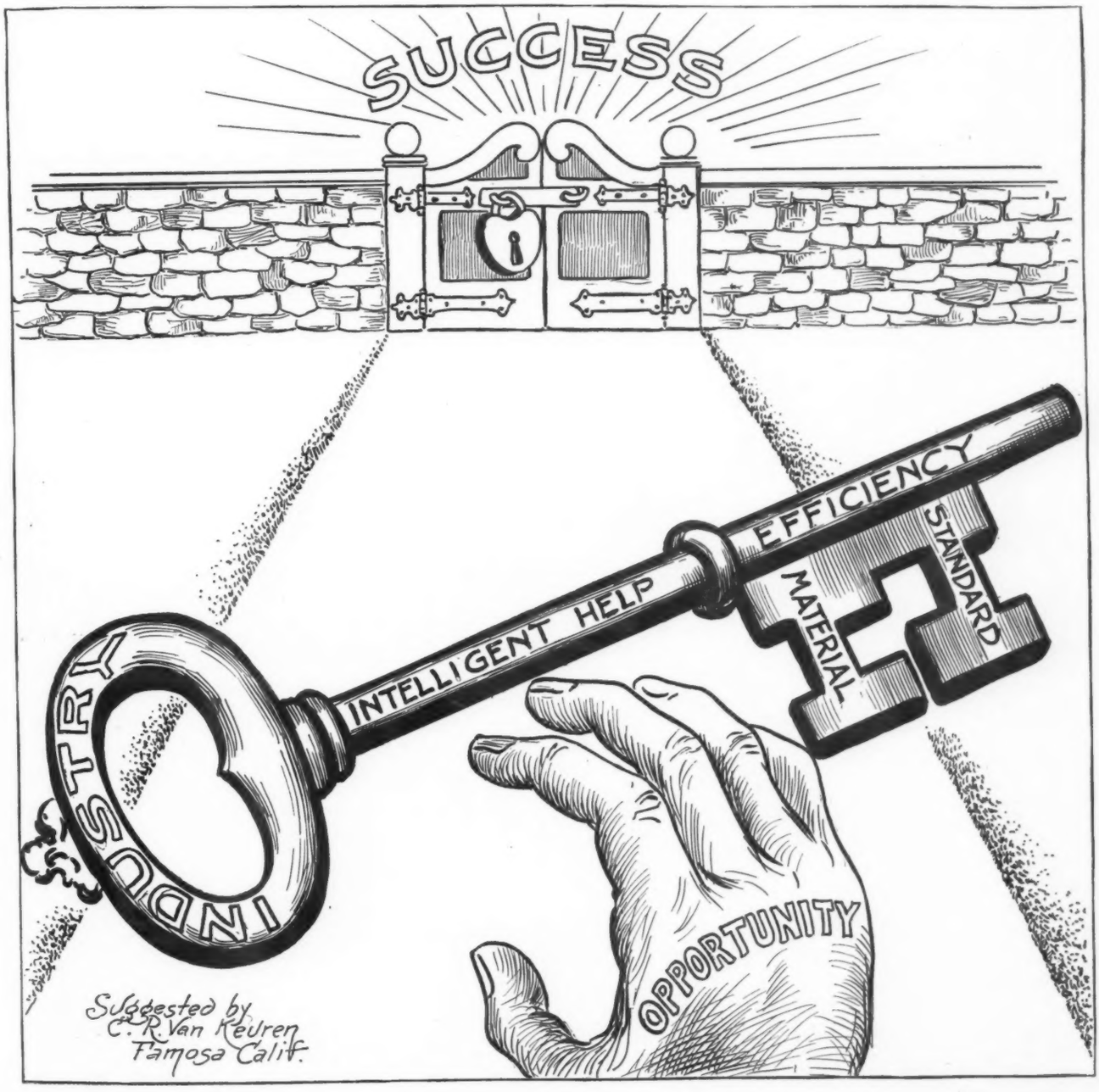
POWER

Vol. 38 NEW YORK, DECEMBER 16, 1913 No. 25



HOW TO GET THERE

Compressed-Air Pumping Plant, Meridian, Idaho

By LeRoy W. Allison

SYNOPSIS—Water from an 8-in. driven well is obtained by an air-lift system. Air is supplied by a motor-driven air compressor, belt connected. Water is stored in a 60,000-gal. steel tank.

The town of Meridian, Idaho, has erected a pumping station, with domestic water-supply system and fire-protection facilities, that offers many interesting features. At a cost of installation and daily operation commensurate with results obtained, the plant and system during a period of more than two years' continuous operation has shown exceptional efficiency.

Air-Lift Pumping Plant, Meridian, Idaho

Water Supply

A site for the plant, including well, pumping station and tower tank, was selected at the highest part of the town. An 8-in. well was driven to a depth of 212 ft. and a 6-in. tubing driven on down to the 252-ft. level. At this point the flow was encountered in a deep stratum of coarse gravel underlying a stratum of tough, solid clay.

Rising to a point about 60 ft. below the surface, the water had a depth of about 192 ft., and such level has been almost continuously maintained. The water is extremely soft, nonmineralized and free from ammonia elements. As taken directly from the well, it has a constant temperature of approximately 52 deg. F.

Under the various conditions to be considered, among them being the size of well tubing, an air-lift installation was decided upon as being the most suitable and effective. An air compressor, driven by a gasoline engine was temporarily operated for testing and cleaning the well. The results obtained were highly satisfactory, indicating a practical inexhaustible supply, and conclusively proving the entire feasibility of lifting the water by a compressed-air system.

Pumping Plant

An exterior view of the pumping station, including the steel water-tower tank, is shown herewith. The well has a 6-in. outlet into a concrete receiving basin. This basin is 10 and 12 by 7 ft., 8 in. deep, and has a capacity of about 8000 gal. A 6-in. outlet for discharging to waste in an outside ditch is also provided; both outlets are fitted with controlling gates.

A concrete suction chamber, 12 ft. 10 in. by 36 ft. 7 in., and 8 in. deep, adjoins and connects with the receiving basin. At the terminus of this chamber, a 4x5-in., two-stage centrifugal pump is installed. Operated at 1120 r.p.m., this pump has a capacity of about 625 gal. per min., with the tank full. It lifts the water from the receiving chamber through a 5-in. discharge line and discharges it into the tank and distribution system. This pump is fitted to operate automatically by a float and weight which, when the water reaches a fixed level in the receiving basin, acts, by a system of levers, on a friction-clutch coupling on the pump shaft.

A 50-hp., three-phase, 60-cycle, 220-volt, alternating-current motor, with starting compensator, is directly connected to the centrifugal pump by this friction-clutch coupling. The motor is belt-connected at 18-ft. centers to a 10x12-in. air compressor, located at the receiving basin. The compressor is equipped with a 3½-in. automatic unloading valve and a 36-in. by 6-ft. vertical air receiver, and is operated at 165 r.p.m. Through a 1½-in. air pipe, suspended in the 6-in. well tubing, the air is sent down 170 ft. in the well. This air pipe is fitted with a reverse elbow at the bottom so that when released the air acts directly in lifting the volume of water.

Water-Works System

The water-works distribution system comprises about 20,000 ft. of 4-in., 6-in. and 8-in., extra-heavy, wood-stave, wire-bound water pipe. This pipe was carefully laid under expert supervision. The trenches were puddled from irrigation ditches, and the tenon ends of the pipes were painted with boiler asphaltum tar before being driven into the couplings. The pipe was kept from sunlight until placed, and is estimated to have a life of at least 40 years. Controlling gate valves divide the system into eight sections.

The steel water-tower tank is 110 ft. high from the top of the foundations to the water surface when full, and has a capacity of 60,000 gal.

Summary of Tests

Shortly after the installation of the plant, tests were made to accurately determine the capacity of the various

components of the station, and the 24-hr. domestic consumption in the town. The results of these tests showed that the maximum capacity of the well was about 225 gal. per min., with air at 38 lb. pressure. At present, after more than two years' continuous pumping, this flow has largely increased. The well capacity with about 40 lb. air pressure is now about 400 gal. per min., which more nearly equalizes the air-compressor and centrifugal-pump capacities.

The capacity of the centrifugal pump, with the tank full, was found to be about 625 gal. per min., as rated. The static head on the pump is about 112 ft., and the suction lift is not over 8 ft.

The time required to fill the receiving basin up to the point where the pump starts to operate automatically was found to be about 34 min.

When the centrifugal pump starts, there are about 7500 gal. in this chamber. To empty the basin when full, with the air compressor discharging from the well at the same time, requires about 18 min. By throttling the gate valve on the force main, the capacity of the pump can be reduced, so that when vitally needed, as in the case of a serious fire, a supply of about 220 gal. per min. can be obtained indefinitely.

The demands upon the plant and system have now considerably increased, but at the time of making these tests were found to be about 64,000 gal. every 24 hr. Based upon meter requirements, and a study of consumers, the estimated actual daily consumption per capita was between 90 to 100 gal., or a domestic daily consumption of about 40,000 to 45,000 gal.

The water unaccounted for lies between 4000 and 9000 gal. per 24 hr. Considering, however, that the line loss, or water unaccounted for any other way, in a well constructed and carefully maintained cast-iron pipe system, with lead joints, will average between 2500 and 3000 gal. per mile of cast-iron pipe per 24 hr., it is seen that this wood-pipe distribution installation is more efficient than the average cast-iron pipe system.

The entire cost of the pumping plant and water-works system was about $24,000 complete. It was designed and erected under the supervision of Edmund M. Blake, to whom the writer is indebted for considerable data regarding this plant.

Further Studies in Corrosion

In addition to the recent studies in corrosion (POWER, Oct. 11, 1913, p. 531; and Oct. 28, 1913, Nov. 18) it is worth while to abstract the conclusions in other recent publications treating this subject. In Technical Paper No. 15 of the Bureau of Mines ("An Electrolytic Method of Preventing Corrosion of Iron and Steel"), J. K. Clement and L. V. Walker have told of studies in the corrosion of iron tubes in diluted acids. They refer at some length to G. Harker's and J. McNamara's results (*Journal Soc. Chem. Ind.*, p. 1286, 1911) in which an iron anode connected to an outside source of power is used to prevent corrosion. Harker concluded that the counter e.m.f. did not prevent the solution of iron from the boiler tube, but that other iron is deposited as fast as it dissolves. From this Clement and Walker differ, but the disagreement is of no consequence to the operating engineer.

However, one practical conclusion of Clement and Walker's is important, they state that a carbon anode (insoluble anode) works equally well with an iron one, if the correct counter e.m.f. be applied. That is, using an external source of power, neither zinc nor iron anodes are necessary, carbon will do the trick. Corrosion and, consequently, the protective current required, are greatly increased by oxygen present in the water, by increase in acidity and by stirring.

The authors give a table by which it is claimed the current necessary for protection can be deduced, but the way of applying it to a boiler or other steam apparatus in actual operation seems to be a mystery. However, it appears that under their experimental conditions three milliamperes per square inch were sufficient to prevent corrosion even with fast stirring. This is equal to 0.75 watt per sq.ft. of protected surface, or 6.6 kw.-hr. per sq.ft. of surface per year. Nothing is said of how far from the electrode such protection extends or of calcium-carbonate protective coatings, as in the Institute of Metals report.

The Microchemistry of Corrosion

A paper by Cecil H. Desch and Samuel White before the Institute of Metals (of Great Britain) deals with microstructure of corrosion. We abstract the conclusions only. They emphasize especially in any experiments dealing with corrosion of brass, the necessity of distinguishing between metal dissolved and that left as a dezincified layer, which may later become detached. In absence of mechanical disturbance, this may be a protection against further loss; usually, however, it is scaled off, exposing fresh surfaces to attack.

There is no evidence that tin alloys have less initial tendency to corrode than pure copper-zinc alloys. The protective action of tin seems mainly mechanical, due to the formation of a peculiarly tough and adherent coating of basic salt, which acts like a protective paint. The presence of iron in the brass greatly accelerates corrosion.

In some experiments of J. Newton Friend, Walter West and J. Lloyd Bentley (*Transactions Iron and Steel Institute*, May, 1913), there seem likewise to be some points worth cognizance by the engineer who is experimenting on corrosion. Certain nickel and chromium steels are more resistant than any carbon steels to corrosion by tap and salt water, high-nickel and high-chromium alloys being most resistant. Nickel steels show less superiority in long tests than in short, they show a wonderful resistance for a time, then break down rapidly, pointing to the conclusion that short trials are not enough. To exercise appreciable influence, the nickel percentage should be over three. A little chromium seems to accelerate the solubility—there seems some reason to believe that with about 5 per cent. the maximum insolubility is reached, and that above that excess chromium again increases the solubility. Nickel-chromium steels are more corrodible than when either metal is taken alone.

Last, and most important to the experimenter, they state:

"It is evident that results in acid-corroding media give relatively no clue to the corrodibility of the metal under ordinary conditions of exposure. This, again, emphasizes the fact that acceleration tests as usually carried out with acids yield misleading results."

This is only too true.

Condenser-Tube Corrosion

In a paper before the Institution of Engineers and Shipbuilders in Scotland (Trans., 56th Session, p. 37), J. H. G. Morrison gives a review of the electrolytic theory of corrosion, then passes on to the practical side, basing his results somewhat on acid-acceleration tests. He believes that lead and iron in the alloys should be kept as low as possible; that zinc plates in the condenser prevent dezincification; and that lining the tubes is a good corrosion preventive, if well done; but if not, is worse than useless.

He also believes that pieces of carbon or cinder, lodging on the tube, may start pitting, apparently in disagreement with Bengough. He suggests placing ash ejectors on the opposite side of vessels from the main injection, and to avoid pumping bilge water through the condenser. Tubes should all be annealed. The exhausts from auxiliaries should be placed so steam does not impinge directly on the tubes. No vegetable or animal oil should be used on any part of the engine whence it can work into the condenser. The speed of the water through it should be not less than 100 ft. per min., to prevent salts from depositing on the tubes.

The remarks of William H. Walker before the Society of Chemical Industry on Apr. 25, 1913 (*Journal Soc. Chem. Ind.*, June 16, 1913, p. 584), are of more than common interest, for Professor Walker has long been the leading exponent of the electrolytic-corrosion theory, and in this speech seemed to depart from it. He says, in part:

> In the first place we have found that the factors controling the rapidity or extent of corrosion are by no means so simple as they were at first thought to be. Many conditions which were considered of little or no importance, have been found to exert a profound influence upon the reactions involved. For example, samples of iron and steel which exhibit marked differences in corrosion exposed in the normal condition in which they came from the mill, fail to show any difference upon exposure, when they are first planed to a uniform surface. Apparently the mechanical strain to which the samples are subjected in the planer, masks or neutralizes the difference in corrosion inherent in the normal material. It is not surprising, therefore, that many conflicting results have been obtained and published from the investigators now interested in this work. Only those tests which have been carried on under identical conditions of surface finish, temperature, access of oxygen and moisture, general atmospheric conditions, etc., should be given any weight, and even when the greatest care is taken, generalizations must be drawn with caution.
>
> One of the conclusions reached by a consideration of the electrolytic theory of corrosion which has proved misleading, is that homogeneity in the material insures protection, while heterogeneity leads to rapid attack. While this is a corollary which may be logically drawn from the electrolytic theory and is doubtless in itself true, there are evidently other factors which superimpose themselves upon those due to differences in structure, producing a final effect contrary to that predicted. The iron of the old chain bridge at Newburyport, Mass., has withstood corrosion in a truly remarkable manner for the last 98 years; and yet it is conspicuous for its heterogeneous structure. Large areas of perfectly pure iron, free from both carbon and slag, are mixed up with areas showing at least two kinds of slag, and very high carbon; yet all withstand atmospheric corrosion. On the other hand, Burgess has shown that iron free from all contaminating elements which could segregate or produce a lack of uniformity, does not withstand rusting so well as the same iron to which has been added a little manganese or copper or nickel. This behavior is observed also in the case of the so called pure irons made in an openhearth furnace, and which are relatively free from carbon, manganese, sulphur, and other constituents prone to segregation, which have come to the writer's notice. While theoretically a pure iron should withstand rust, there are apparently some factors present which more than offset any advantage inherent in purity. Obviously, conditions affecting the surface of the material so soon as rusting has started, are important causes which have largely been overlooked and which demand more thorough investigation. . . .
>
> Several hypotheses have suggested themselves as explaining the marked effect of copper in causing steel to resist atmospheric corrosion, but as yet none is sufficiently tangible to afford a working theory.
>
> Rapid progress has been made in acquiring that knowledge of the relation of pigments and finished paints to corrosion, which is necessary to a better protection of iron and steel. Predictions founded on theory that a basic paint, or one containing a chromate pigment would inhibit rusting while one made up from lamp black or graphite would accelerate rusting, have, in the main, been found correct. The effect of the pigment upon the character of the oil film making up the paint, however, has shown itself also to be very important. Many basic pigments, such as basic lead carbonate or zinc oxide, which in themselves inhibit, do not withstand the weather; lamp black and graphite, on the other hand, make a very impervious and highly resistant paint film. The logical conclusion in protecting iron is, therefore, to use a basic priming coat, a second coat of a mixture of a basic pigment and a little lamp black, and when well dried out to apply a lamp black or graphite finishing coat. Experience has shown also the importance of brushing the paint well on to the iron; a good paint may fail on account of poor application.
>
> Careful tests with galvanized work show that an even coating of zinc is the all-important factor. The common practice of clean wiping galvanized ware is fatal to durability, since the protecting layer is not metallic zinc, but a thin deposit of a zinc-iron alloy. While, therefore, much has been accomplished in the way of making a more resistant base, there is still a necessity for a uniform substantial coating of spelter over the surface.

Automatic and Hand-Controlled Unloading and Reducing Valves

The purpose of this valve is, when placed in a steam line between a high- and low-pressure boiler, to automatically open and discharge the high-pressure into the low-pressure line to whatever pressure the valve is adjusted.

The valve shown in the accompanying illustration is in a closed position, due to the compression on the springs *BB*, which are adjusted by the nuts *AA*, thereby overcoming the high pressure on top of the diaphragm. When this pressure increases above the point at which the springs are adjusted, the valve will open. The position of the spindle, as shown, is for automatic service and is locked by the lever *F*. For closing the valve by hand, the lever *F* is thrown out of the locked position, which will allow the valve spindle *G* to rise.

The steam above and below the piston *D* and also above the diaphragm, prevents chattering or hammering and cushions the valve in opening and closing.

Should it be desired to renew the rubber diaphragm of the valve, which is made by the Golden-Anderson Valve Specialty Co., 1217 Fulton Bldg., Pittsburgh, Penn., the sleeve *C* is screwed down until it locks itself; this allows the piston *D* to come in contact with the seat *E*, closing off the steam pressure above the diaphragm by turning down on the handwheel.

In Fig. 2 is shown an automatic steam-pressure reducing valve in a closed position. The diaphragm *D* is of copper. When the pressure on the low side has reached the pressure at which the valve or springs are set, the pres-

sure, still increasing, exerts a pressure on top of the valve *H*, whose area is greater than *G*, and will force the valve closed. The valve in closing compresses the large springs, thus avoiding sudden closing, chattering or hammering. The port above the diaphragm is for the purpose of preventing any leakage of steam that may escape around valve and spindle, thus coming in contact with the diaphragm. The large piston *M* cushions the valve in opening and closing. These valves are desirable where accurate and constant regulation is required.

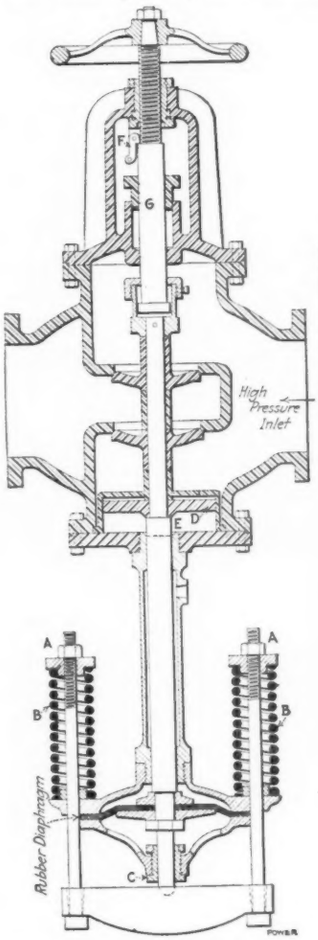


FIG. 1. HAND-CONTROLLED UNLOADING VALVE

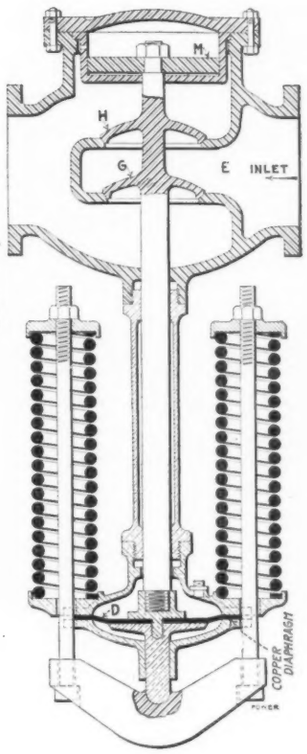


FIG. 2. REDUCING VALVE IN CLOSED POSITION

❖

Crane-Erwood Double-Acting Nonreturn Cutout Valve

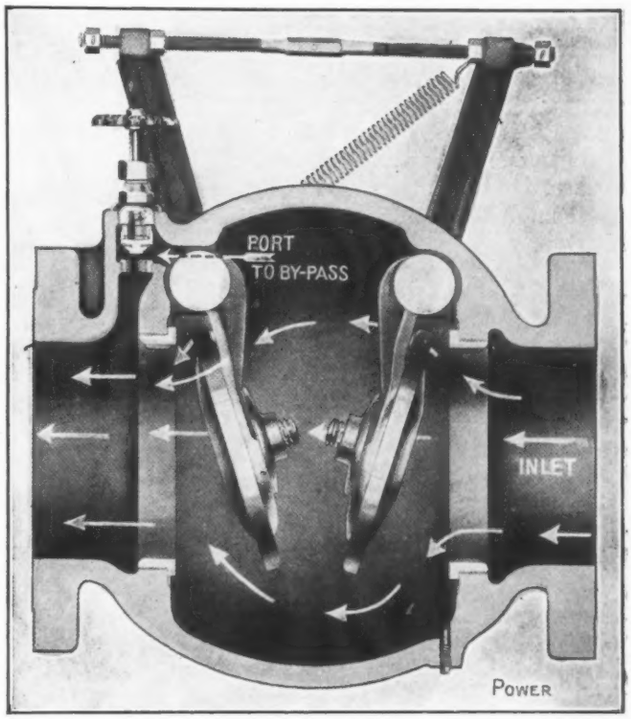
These valves are designed to close automatically in case the operator opens a large valve too quickly. It also acts as a protection to a boiler in the event of a tube bursting, as its nonreturn feature prevents the back flow of steam from the main.

The valve will also open automatically when the boiler to which it is connected reaches the full pressure in the main, but will remain closed at a higher pressure in the main; consequently a sluggish boiler may be readily detected.

In the accompanying illustration, a sectional view of the valve is shown. The levers on the outside of the valve are in line with the disks, and give an indication of their position at all times.

The separate link, connecting the outside levers, may be adjusted to suit the load to be carried. Shortening the link decreases the volume of steam passing through the valve; lengthening the link increases the volume and does not interfere with the automatic operation of the valve. The valve may be adjusted to close at any desired velocity, from the outside of the valve.

This valve, which is manufactured by the Crane Co., 836 Michigan Ave., Chicago, Ill., is made with a ferrosteel body and hard-metal seats and disks, and is adapted for operation on steam pressure up to 250 lb. at a maximum temperature of 500 deg. F. The valve may be arranged for electrical remote control and may be used for the protection of long lines of branch piping.



VALVE IN NORMAL POSITION WITH FULL VOLUME OF STEAM PASSING

❖

Municipal Plants Good Assets—The light plant and water works are working successfully under ownership of Cambridge City, Ind., and are the biggest assets it has in keeping down tax rate. Recently a large addition was built to the light plant. It has three machines with an aggregate capacity of 350 hp. It will not be necessary to use the machinery to capacity for several years unless additional factory power is sold. The plant has a good day service as well as night and runs for 24 hours. Half a dozen factories use the power during the day and the streets are electrically lighted all night. Most of the houses are lighted by electricity. The water works, which has been town property but a short time, was improved a short time ago and now bears the distinction of using one of the two of its kind of filtering system north of the Ohio river. The water was formerly pumped from the Hagerstown canal but this was generally accepted as being unsatisfactory. The town board then ordered wells dug. At the depth of 30 ft. hard pan was struck. Boring through 5 ft. of hard pan, a vein of excellent water, flowing through gravel at the depth of 35 ft., was found. This is 5 ft. deep and rests on hard pan. The bottom of the supply well is 40 ft. deep. The filtering system is so arranged that the unfiltered water flows above in the well. Following the filtering process, the water is pumped up from the lower strata through the lower part of the filter.

Stationary-Boiler Pop Safety Valves

By Warren O. Rogers

SYNOPSIS—A description of the method of adjusting the blowing-off point of the principal makes of pop safety valves, also the manner in which the amount of blow down is adjusted.

The simplest form of safety valve is what is known as the dead-weight type, in which the valve disk is held against its seat and the boiler pressure by a weight. Although this type of valve is simple it is cumbersome and not adaptable for high pressures. It is seldom seen in this country except on heating boilers, although it was commonly used extensively in European countries before high pressures prevailed.

With pressures ranging around 100 lb. the lever safety valve is common in many states. Although thousands of these valves have been used in this country, they are not considered a safe valve, because of the tendency to stick instead of operating to relieve the boiler of excessive pressure. According to the Massachusetts Boiler Rules, all safety valves placed on boilers must be of the direct spring-loaded type. In fact, nothing but spring pop safety valves are now found in the better class of steam plants.

In a pop safety valve the steam pressure acts upon the under side of the valve disk, and is resisted by the tension of a spring. When the steam pressure exceeds the resistance of the spring the valve lifts from its seat and the steam escapes to the atmosphere.

Pop safety valves have been used in this country about 40 years, and have been in general use about 30 years. There are two kinds of pop safety valves: one having an addition to the valve disk, so designed that when the valve is closed the addition is cut off from the action of the steam, but when the valve opens the escaping steam from the boiler acts upon it, which, with the initial force causes the disk to rise higher and compressing the spring more than would be caused by the ordinary disk alone. This gives a larger opening at the seat through which a greater quantity of steam will flow in a given time in releasing a boiler of excess pressure. The other kind of valve has the additional area located at the center of the disk, and within the outer seat and excluded from the action of the steam by means of an inner seat, upon which when the valve opens the steam acts directly.

In either valve when the disk lifts from its seat, the escaping steam acts upon one or the other of these additional areas, causing the spring to be compressed in proportion to the power exerted upon the initial and additional areas respectively. This forces the disk to rise higher and affords an outlet for the discharge of steam greater than would otherwise have been provided had it not been for such additional area.

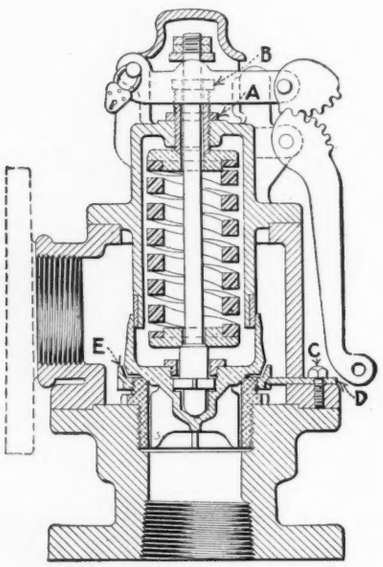


Fig. 1

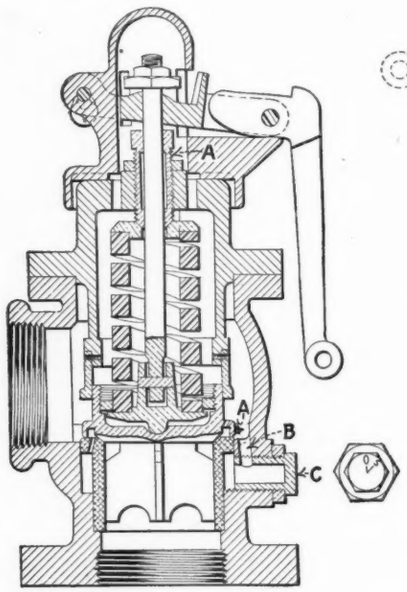


Fig. 2

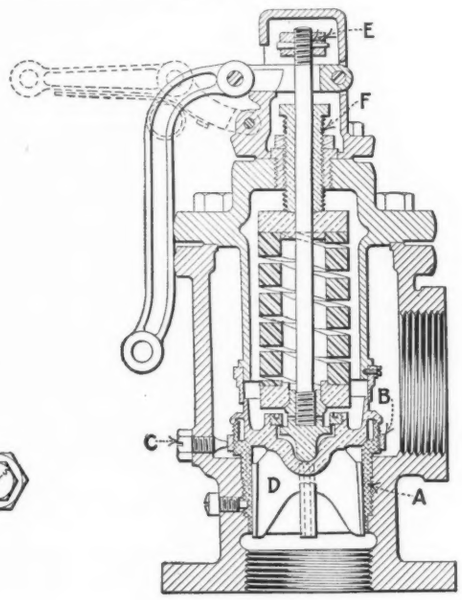


Fig. 3

As the safety valve is the most important fitting on a boiler it must necessarily be so constructed as to be sensitive to any excess pressure beyond the point at which it is set, and to give instant and positive relief to the boiler to which it is attached. In construction it must be durable, so as to maintain positive action under the most exacting conditions.

There are numerous makers of pop safety valves on the market, several of which are described and illustrated herewith.

Lonergan Valve

In Fig. 1 is shown a Lonergan pop safety valve. It is designed to give a large relief, that is, when in the act of popping the disk has a good lift off its seat, but not enough to relieve the boiler too suddenly, or to draw water out of the boiler. If the lift of the valve disk is too little the valve seat is likely to be damaged by the wire-drawing action of the steam in passing through the valve.

The valve is made to operate with a 0.10-in. lift, although it can be made to suit any requirement up to 0.1875-in. lift at the popping pressure. The spring, which is the principal factor in safety-valve construction, is made of steel and so designed that when compressed to the popping point the fiber stresses are not more than one-half of the fiber stress of the elastic limit of the steel in the spring.

Referring to the illustration it will be seen that the spring is protected from the steam by the relieved star guide on the outside of the spring chamber, thus doing away with back pressure on the top of the star. The spring chamber beside protecting the spring from the discharging steam also prevents back pressure on the top of the valve disk when the outlet is piped.

The spring rests on a spring step, which makes a ball joint with the spindle, to equalize any unevenness in the spring. The spindle has a bearing at least one-half the size of the valve diameter below the seat which reduces the friction to a minimum when the valve is in operation.

To prevent tampering with the adjustment of the valve after being once set, it is provided with a lock-up attachment, as shown. Another feature is the double-eccentric lifting gear with which the valve disk can be lifted one-eighth of its diameter off its seat, with no steam pressure under the valve seat.

This safety valve is adjusted for blowing off pressure by removing the cap and loosening the locknut *A*, and turn the compensating screw *B* to the left, or up, to decrease the popping point, and to the right, or down, to increase the popping point. One-quarter turn of the compression screw will change the popping point from 5 to 10 lb. After making any changes the locknut is tightened before putting the valve in service again. The blow down of this valve should be between 3 and 4 lb. before the valve closes after popping.

If it is desirable to change the number of pounds blow down, the cap bolt *C* is unscrewed and the ring pin *D* removed. A pointed instrument is then used to turn the adjustable ring *E* to the left, or up, to increase the number of pounds blow down, or to the right, or down, to decrease the number of pounds blow down. The ring should not be moved more than two or three notches at a time. If the valve shows a tendency to chatter, the adjustable ring should be screwed to the left, or up.

Ashton Valve

What is known as No. 20 iron-body Ashton valve is illustrated in Fig. 2. This valve is made to work with a close regulation pop of approximately 3 lb. As indicated, the spring is inclosed in a casing and is thus protected from the volume of steam escaping from the boiler when the valve is operating.

The pop chamber is of special design in that it is surrounded by a knife-edge lip *A* and is inclosed within the walls of the lip and top of the bushing and valve seat. The knife-edge lip wears down in proportion to the wear of the seat of the valve, keeping the outlet of the chamber of the same relative proportion to the inlet, giving an unvarying pop and insuring long service without readjustment or repairs. A supplemental pop chamber is connected with the primary pop chamber by a series of relief holes *B*, through the bushing *C*.

Close regulation of the pop is made by adjusting the size of the opening into the discharge chamber. When it becomes desirable to adjust the pressure it is only necessary to remove the lock, pin and lever and after removing the cap, slack the check nut on the adjusting screw. Turning the screw downward increases the pressure, turning upward adjusts the spring for less pressure. Should a change in pressure of more than 15 lb. be desired, a new spring should be used.

Should it be desirable to change the amount of reduction in pressure when the valve operates, it is only necessary to regulate the screw-plug regulator *C* on the outside of the valve. If more pop is wanted, slack the check nut and turn the regulator slightly to the left, so that the letter *S* stands nearly perpendicular. For less pop the regulator is turned to the right until the letter *O* is nearly perpendicular. One-sixth of a turn of the regulator gives the full range of adjustment.

In order to give the spring a true bearing on the valve disk, it is fitted with pivoted top and bottom disks. The valve is made with a trip lever which can be changed to operate in any desired direction regardless of the position of the valve, and has the power to lift the valve disk from its seat at any pressure by hand.

Lunkenheimer Safety Valve

All approved patterns of safety valves are designed along similar lines, and of similar materials, the main idea being to make a valve that will operate promptly under the most exacting conditions. Such a valve is found in the Lunkenheimer safety valve, Fig. 3. In this valve the seat is beveled at an angle of 45 deg. to the vertical axis. It is provided with a lock-key attachment to guard against the adjustment being tampered with.

In this valve the bronze seat *A* is screwed into the valve body. The seat ring is provided with a regulating ring *B*, which is screwed up or down to regulate the pop. It is held in any desired position by the screw *C*. The valve *D* is guided by the wings on the bottom as it operates inside the seat ring *B*.

Provision has been made for regrinding the valve disk and seat by turning the stem *E*. The steel spring is held in place by top and bottom ball-seated plates, which keep the spring in alignment. The spring is protected from the action of the steam by the casing in which it is confined. The tension of the spring is regulated by the regulating screw *F*, which operates in a bronze bushing. A locknut holds the regulating screw in any desired position.

Should a higher pressure be desired the regulating screw is turned down; for a lower pressure it is turned up. The amount of escaping steam is regulated by the ring *B*. After removing the plug *C* a rod can be inserted to engage the notches around the regulating ring. Should the valve not reduce the pressure enough the ring *B* is turned up, covering the holes in the seat ring and causes the valve disk to lift higher and remain longer off its seat. If the valve reduces the pressure too much the ring *B* is turned down. When the desired adjustment has been obtained the ring is secured in place by the screw *C*.

Crane Valve

The construction of this valve embodies a self-adjusting feature which automatically regulates the pop of the valve and, thereby, permits moderate changes in the setting pressure and maintaining but little steam waste between the opening and closing points. It is necessary

in this type of valve to have a chamber into which the steam expands when the main valve opens, thereby creating an additional lifting force, in proportion to the increased area, sufficient to compensate for the increased tension exerted by the main spring, due to the further compression caused by the opening of the main valve. Therefore, the main valve is held open until the boiler pressure is relieved.

The pop chamber is relieved of pressure to allow the main valve to close promptly by the action of a self-adjusting auxiliary valve *A* and the spring *B*, which operate independently of the main valve and spring. The steam in the pop chamber passes through ports into an annular space provided in the auxiliary valve and lifts the valve disk against the tension of the auxiliary spring, allowing the steam in the pop chamber to gradually escape. This action supplies a balancing medium to ease the seating of the main valve disk without chattering or hammering. If it is desirable to change the point of blowing off within reasonable limits the screw-pressure

In Figs. 5 and 6 are shown the design of valve used for saturated and superheated steam in which the spring is comparatively large. It is supported by washers arranged for ball bearing on a spindle on the lower end and on a compression screw on the other end, whereby any distortion of the spring in compression does not cramp the spindle or cut the disk. The spring is protected from the heat of the escaping steam by the casing, as shown.

The popping pressure is adjusted by removing the cap and lever, loosening the check nut on the compression screw and turning the screw downward with a wrench to increase the popping pressure, or turning the screw out to decrease the popping pressure. When it is desired to adjust the blow down, the locking pin *A* in the side of the valve body is removed and the notched ring, which is threaded on the seat bushing, is turned upward to increase the blow down, or in the opposite direction to decrease the same. The usual adjustment of 5 lb. can be increased to 15 lb. if desired, or it can be decreased to less than 2 lb. The action of the valve, however, with a

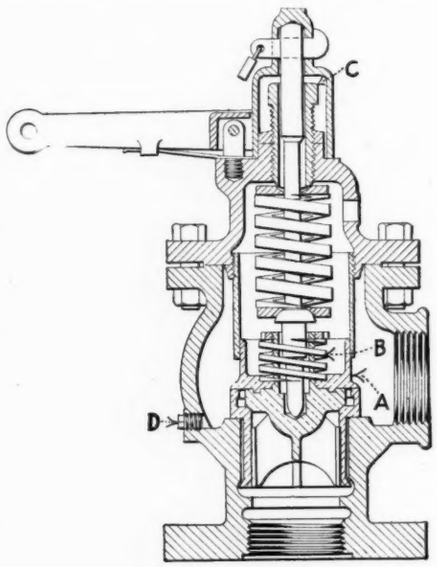


FIG. 4

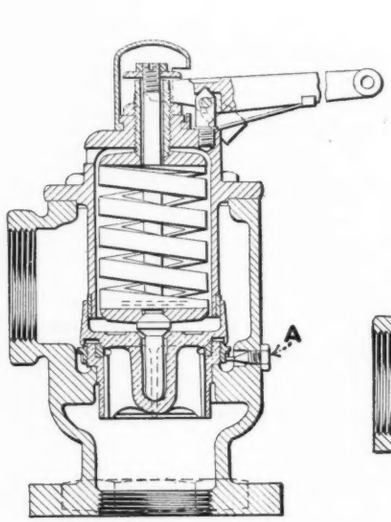


FIG. 5

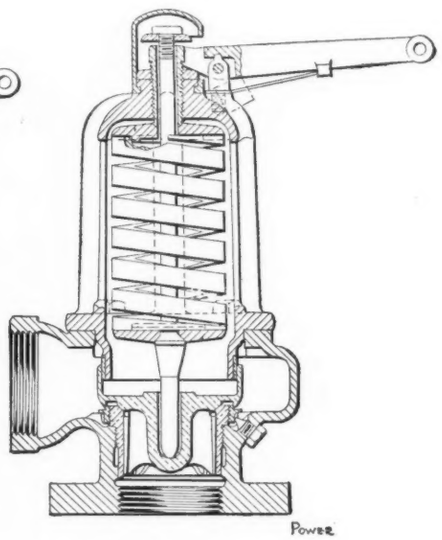


FIG. 6

plug *C*, at the top of the valve, is turned in or out for a higher or lower pressure. The valve is self-adjusting within reasonable limits and there is no necessity of readjusting the auxiliary valve to regulate the pop should it be desired to make a moderate change in the set pressure. The valve is provided with a cam lever which will lift the valve disk from its seat one-eighth the diameter of the valve opening; the lever can also be thrown over far enough to lock the valve open should occasion require.

CONSOLIDATED SAFETY VALVE

Aside from mechanical reliability the most vital factor in a safety valve is its capacity, which is dependent upon the area of discharge through the valve or relieving capacity. The makers of this valve, after two years' experimenting, redesigned their line of safety valves to conform to the formula they found to be correct for determining the proper valve rating according to their actual relieving capacities. Therefore, with each type of valve a spring of suitable proportions was calculated and the valve case was then built around the spring.

blow down of 4 to 5 lb. is cleaner and more positive than with a lesser blow down. In the superheated steam valve the spring is placed above the discharge opening and is cooled by contact with the external air.

CROSBY POP SAFETY VALVE

The iron-body Crosby pop safety valve is made in two styles, the "Standard" type for pressures up to 200 lb., and a heavier pattern called the "Inspector" valve. The shapes and proportions of the seats and regulating lips of both valves are the same. These valves are illustrated in Figs. 7 and 8.

One distinguishing feature of these bevel-seated valves is that the ring by which the blow down is regulated does not surround the edge of the lip of the valve disk to cover the opening at the moment of opening. When the valve is closed, the outer edge of the lip on the disk is always slightly above and clear of the edge of the lip of the seat gallery. The lip of the disk is shaped to obtain the greatest lifting effect from the impact of the outflowing steam.

The regulation of the blow down is effected by deflecting the escaping steam downward inside the lip, against the bottom of the lip chamber, which is drilled with a number of vent holes through which the steam escapes, more or less rapidly, according to the position of the regulating ring. This discharge of steam is added to the main discharge over the valve lip.

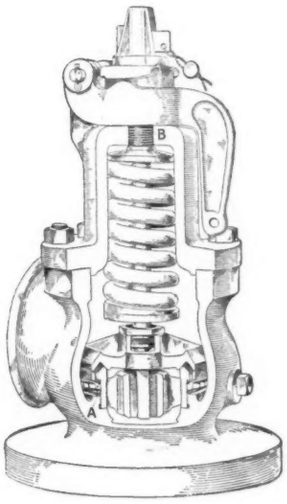


FIG. 7

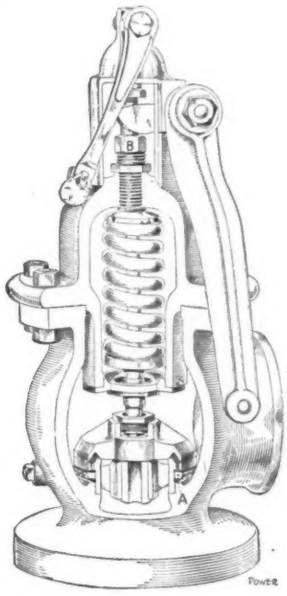


FIG. 8

When the regulating ring is screwed upward close against the under face of the lip chamber it practically closes the vent holes, and all steam is forced over the lip, which increases the pressure in the lip chamber and causes the valve disk to lift higher, keeping the valve open longer. This results in a greater drop in boiler pressure before the valve closes. If the ring is screwed down, and a greater part of the steam escapes through the vent holes, less steam passes over the lip, the valve opens less and closes with less loss of boiler pressure.

The valve disk is mushroom shaped and has a guide much smaller than the diameter of the seat, which is made with a hub about one-quarter the valve diameter, and placed below the level of the valve seat. This prevents cutting of the valve seats, therefore the wear is more uniform around the whole circumference of the seat and the valve will operate longer without leaking and without requiring refacing.

The Standard type of valve, Fig. 7, has the spindle rod slotted near the upper end and a cap and key form a means of lifting the valve disk by the lever. This valve is made either with the spring exposed to the temperature of the exhaust steam or in an inclosed chamber similar to the method employed in the "Inspector" valve, Fig. 8, which is made with heavier walls. This latter valve is adapted for use on saturated steam up to the highest working pressures now available. The spring chamber is drained at the bottom and the lower end of the valve stem moves freely in a hole having sufficient clearance to prevent binding. Valves used with superheated steam are made with steel bodies in either type of valve.

The "Inspector" valve is made with a hinged cap which covers the adjusting bolt and lifting device. When this is in its normal position, with a bolt through it locked in place, it is impossible to change the set pressure of the valve or to tamper with it.

In both valves the spindle rod is provided at its lower end with a steel-inserted nose which gives an effective bearing for the spring pressure.

Each type of valve is fitted with a spring of round steel, the tension of which is adjusted by the head bolt *B*.

❖

An American Locomobile

At the recent meeting of the Ohio Society of Mechanical, Electrical and Steam Engineers, George S. Cooper, mechanical engineer of the Buckeye Engine Co., read a paper upon the locomobile which they have undertaken to introduce into American practice under the name of the Buckeyemobile.* After describing the unit he said:

Carefully conducted tests have been run from time to time to determine the efficiency with various grades of coal and with modifications of the furnace and grates. Table 1 presents the average results of seven tests run with Pocahontas coal. Column A is the average of three tests run at about 95 per cent. of the rated load. B is the average of two tests at 14 per cent. overload, and C two tests at 36 per cent. overload. Fig. 1 presents the principal conclusions in graphical form. Note especially the flatness of the economy curves demonstrating the ability of the locomobile to handle large overloads with a scarcely perceptible loss of efficiency. While not shown in this series, other tests show that the same valuable characteristic is possessed at underloads. The three-quarter load fuel consumption is within 5 per cent. of the rating and even at half load the coal consumption is less than 20 per cent. greater per horsepower than at rated load.

TABLE I.

	A	B	C
Load, per cent	95.	114.	136.
Indicated horsepower	166	199	237
Kilowatts	99.4	121.5	146.8
Rev. per min.	206	209	208
Steam pressure, lb.	209	208	207
Saturation temperature, deg. F.	391	391	390
Steam temp. at throttle, deg. F.	638	673	668
Initial superheat, deg. F.	247	282	278
Hp. exhaust temp., deg. F.	313	353	387
Receiver pressure, lb.	13	18	27
L-p. inlet temp., deg. F.	413	432	457
L-p. superheat, deg. F.	169	178	188
L-p. exhaust temp., deg. F.	146	150	162
Feed-water temp., deg. F.	131	132	138
Vacuum (ref'd to 30″ Bar.) in hg.	25.6	24.3	24.3
Temp. gases base of stack, deg. F.	501	558	578
Total steam per hr., lb.	1626	1970	2420
Steam per i.hp.-hr., lb.	9.8	9.9	10.2
Steam per kw.-hr., lb.	16.35	16.3	16.5
Total coal fired per hr., lb.	192	238	283
Coal per i.hp.-hr., lb.	1.16	1.195	1.195
Coal per kw.-hr., lb.	1.94	1.96	1.93
Boiler and superheater eff., per cent.	76.9	76.6	77.0
Thermal eff. of engine, per cent.	19.8	19.7	19.5
Thermal eff. of unit, per cent.	15.6	15.1	15.0
Heat value of coal, B.t.u.	14,136	14,099	14,215

In comparing the above results with other power-plant data, it should be remembered that the locomobile is essentially a small- or moderate-sized plant. Small steam plants are usually quite wasteful of fuel for several reasons. In the first place small engines are almost always of the high-speed, noncondensing type, using 30 to 40 lb. of steam per hp.-hr. Radiation losses are relatively greater in small plants than in large ones, due to the fact that small boilers, cylinders and pipes expose more surface per pound of steam carried than large ones. To equip a small plant with economizers, condensers, superheaters, etc., is not often commercially feasible since small apparatus of this class is usually much more costly per

*Described in "Power," Sept. 20, 1913.

horsepower than that used in large plants. Fig. 2 is presented to show clearly the effect of plant capacity on economy, and to impress the fact that in the locomobile we possess the means of reducing power costs in a 50- or 75-hp. plant as low or even lower than in the central station with its large units. This fact is further elucidated in Fig. 3 which shows to an accurate scale the distribution of the heat losses and the comparative fuel consumption of a number of typical power plants. The total length of each diagram, exclusive of the part in broken lines, is proportional to the coal consumed per horsepower per hour. The heavily shaded portion of each diagram is proportional to the number (2545) of heat units actually converted into work per horsepower per hour. The lightly shaded portions at the left represent the boiler-room losses and include that due to incomplete combustion and loss to the ashpit, radiation from boilers and setting, and waste in the hot chimney gas. The small portions with vertical shading show the heat expended in driving the boiler-feed pumps and other auxiliaries. The unshaded sections on the right are proportional to the heat rejected in the engine exhaust, and the lengths of these sections, measured to the B.t.u. scale, show the amounts of heat available for heating purposes in connection with noncondensing operation.

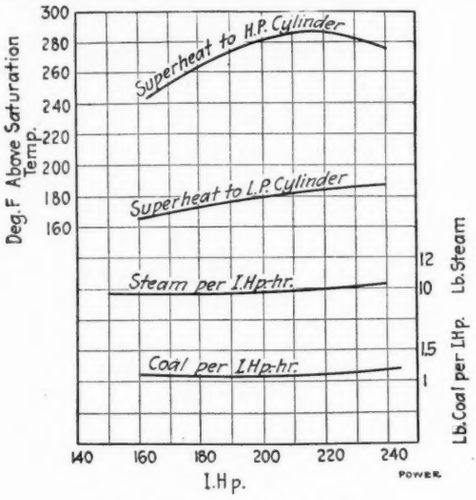


FIG. 1. ECONOMY TEST

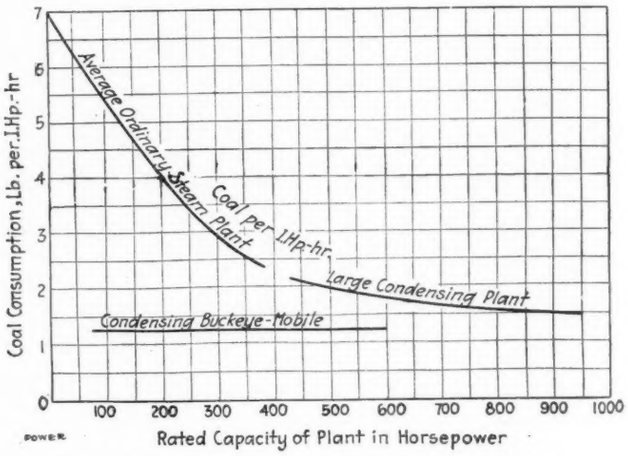


FIG. 2. COMPARISON BETWEEN BUCKEYEMOBILE AND ORDINARY PLANT

The areas inclosed in broken lines represent the heat recovered to the boiler by the feed-water heater. All these quantities may be measured with the scale at the bottom of the chart either in B.t.u. or pounds of coal per hp.-hr. The boiler efficiency in each case is found by

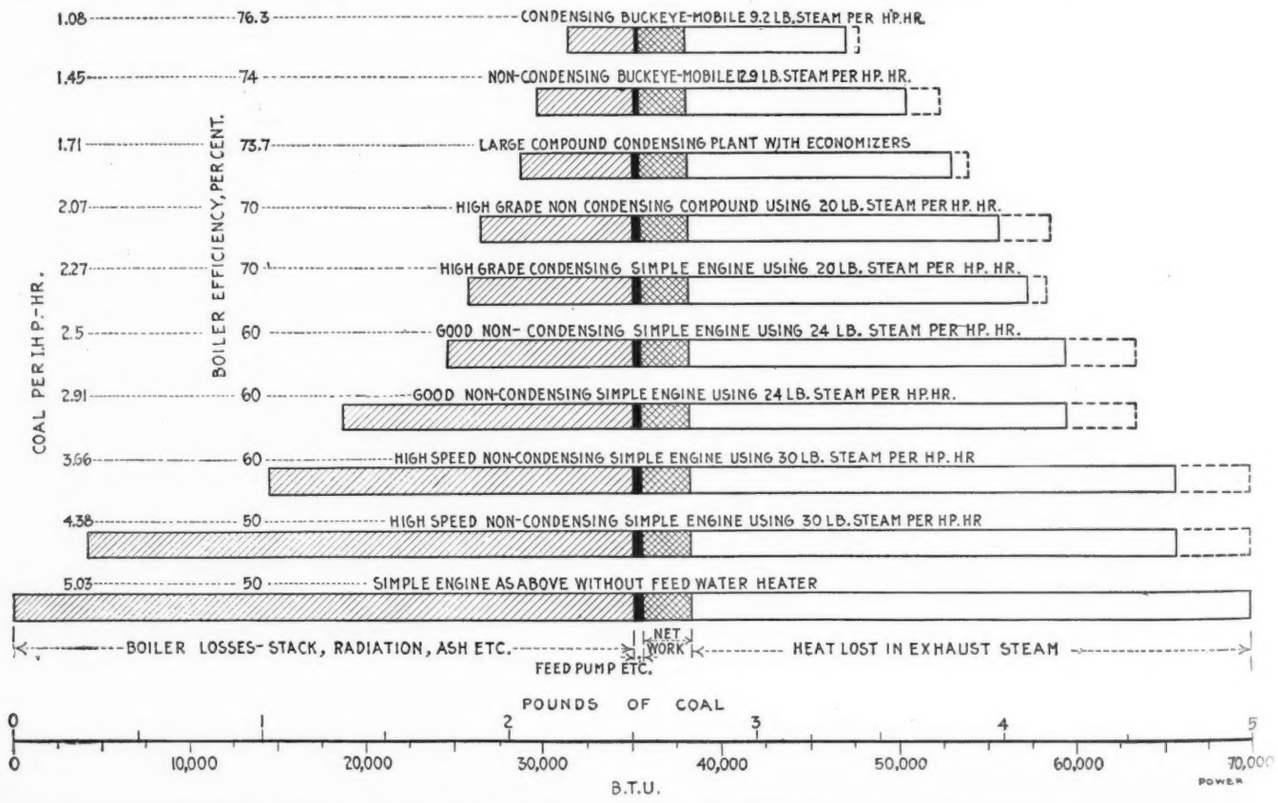

COAL PER I.H.P.-HR.
BOILER EFFICIENCY, PERCENT.
1.08 76.3 CONDENSING BUCKEYE-MOBILE 9.2 LB. STEAM PER HP.HR.
1.45 74 NON-CONDENSING BUCKEYE-MOBILE 12.9 LB. STEAM PER HP. HR.
1.71 73.7 LARGE COMPOUND CONDENSING PLANT WITH ECONOMIZERS
2.07 70 HIGH GRADE NON CONDENSING COMPOUND USING 20 LB. STEAM PER HP. HR.
2.27 70 HIGH GRADE CONDENSING SIMPLE ENGINE USING 20 LB. STEAM PER HP. HR.
2.5 60 GOOD NON- CONDENSING SIMPLE ENGINE USING 24 LB. STEAM PER HP. HR.
2.91 60 GOOD NON-CONDENSING SIMPLE ENGINE USING 24 LB. STEAM PER HP.HR.
3.66 60 HIGH SPEED NON-CONDENSING SIMPLE ENGINE USING 30 LB. STEAM PER HP. HR
4.38 50 HIGH SPEED NON-CONDENSING SIMPLE ENGINE USING 30 LB. STEAM PER HP.HR
5.03 50 SIMPLE ENGINE AS ABOVE WITHOUT FEED WATER HEATER
BOILER LOSSES- STACK, RADIATION, ASH ETC.
NET WORK
HEAT LOST IN EXHAUST STEAM
FEED PUMP ETC.
POUNDS OF COAL
0
1
2
3
4
5
0
10,000
20,000
30,000
40,000
50,000
60,000
70,000
B.T.U.
POWER

FIG. 3. COMPARATIVE HEAT LOSSES AND COAL CONSUMPTION OF TYPICAL PLANTS

dividing the sum of the lengths of the portions representing net work and exhaust loss by the total length of the diagram. The "net work" portion divided by the total length equals the thermal efficiency of the entire plant.

Observe that in the case of the simple engine plant at the bottom of the chart less than 4 per cent. of the heat of the fuel is converted into work, while the condensing Buckeyemobile shows an efficiency of 17 per cent., and the noncondensing Buckeyemobile shows an efficiency of 12 per cent.

The data for the third example in the chart (large compound condensing plant) are taken from "Kent's Mechanical Engineers' Pocket Book," 10th edition, page 985. Note that it is a plant of large capacity with fuel economizers and is regarded as one of the most efficient plants in existence and yet it is surpassed in fuel economy by the Buckeyemobile in sizes as small as 100 hp.

The apparatus in the above chosen examples is assumed to be in good physical condition, free from steam leaks or other obvious defects.

Running Centrifugal Fans in Parallel

By L. B. Lent

SYNOPSIS—To lessen the difficulty of operating fans in parallel, the piping should be carefully proportioned, and pitot tubes for measuring velocity head in the discharge of each fan should lead to a common scale board.

When the discharge from two or more centrifugal fans is delivered into a common discharge pipe, these fans are said to be running in parallel. The pressure in each case is that which one machine alone would develop, but the air delivered is the sum of the volumes discharged by each fan.

Running the discharge from several fans into a common main or header seems, at first thought, to be a simple matter of connecting the fans up in this manner; but one has but to try it to discover that operation under this arrangement is impossible except under certain conditions. The writer's experience may be typical and serve to point out the essentials of proper operation under the conditions.

Two large single-stage turbine blowers were connected to a discharge main, as shown in the illustration. When first installed, one fan was sufficient to furnish the necessary air, at about 2 lb. pressure, to serve the oil burners in a number of metal-heating furnaces. The other fan served as a reserve unit and they were run alternately. A rapidly increasing demand for air made it necessary to run both fans together and, eventually, to add a third.

It was only necessary to start the second fan, the first one being already in operation, to discover that it would not deliver any air and that the first fan was actually blowing air right back through it. These two fans were of the same size, direct-connected to similar direct-current motors and ran at the same speed.

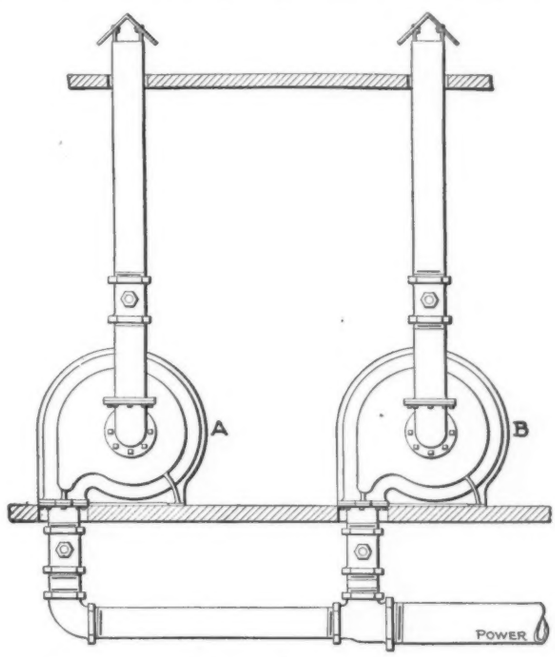
An analysis of the action of a centrifugal fan and the flow of air in pipes will show under what conditions centrifugal fans may be operated in parallel. Three facts must be clearly conceived and borne in mind. They are:

1. For a given fan, the air pressure generated depends upon the peripheral velocity of the wheel or runner.

2. This pressure can be generated and maintained within the fan casing whether air is being discharged or not by running the fan up to speed with the discharge valve closed.

3. The total head of air in motion is the sum of two separate heads—the static head and the velocity head—the sum being called the dynamic head.

When air is under pressure in a closed vessel, a receiver for instance, its pressure may be measured by a pressure gage, or if light, by a water column. This pressure existing in the quiescent gas is called the static pressure, and often its static head, being commonly expressed in pounds per square inch, inches of mercury or inches of water. When air under pressure is flowing in a pipe, the velocity of flow is due to a drop in pressure and is proportional



Fans in Parallel

to a certain difference in pressure. The head equivalent to the velocity is commonly called the velocity head and sometimes the kinetic head. The sum of the static and the velocity heads is the dynamic head.

When a centrifugal fan is started and brought up to maximum speed, with the discharge pipe entirely closed off, the air in the casing is whirled around with the fan blades and the static pressure measured in the discharge pipe is that due to the linear speed of the blades. With no air being delivered, the fan will absorb only a small amount of power. It is only when air is actually discharged against a resistance that more power is absorbed by the fan. When air is moving in a pipe, the velocity with which it is moving is equivalent to a certain pressure, and the velocity head is easily and accurately measured in units of pressure by means of the pitot tube.

An examination of air tables, referring to fan work,

will show that the velocity component is a considerable part of the total pressure. It is the velocity head, due to the inertia of the moving air, which must be dealt with when running fans in parallel.

Referring to the illustration, when fan *B* was running and delivering air at a static pressure of 2 lb., fan *A* was started and brought up to the same static pressure as fan *B*, but not a cubic foot of air did it deliver. On the contrary, air was actually flowing out of the intake pipe of fan *A*. The reason was, that the air being delivered from *B* was flowing at some velocity instead of being at rest and, consequently, had a velocity head in addition to a static head of 2 lb. If the velocity head be assumed at ½ lb., then the total or dynamic head of the discharge from *B* is 2½ lb. Since no air is really flowing from *A*, even though the wheel be running at a speed sufficient to generate a static pressure of 2 lb., the total head (static and velocity) at the fitting below *B* is greater than the total head (static only) existing at the outlet valve of *A*. As soon as the outlet valve of *A* is opened, the greater pressure will actually force air back through fan *A*. To make *A* deliver air, it is necessary to throttle the discharge from *B* until the dynamic head at *B* decreases to an amount equal to or slightly less than that at *A*.

Some form of measuring instrument must be used to indicate the discharge from each fan, so that it may be positively known that each fan is delivering its proportion of the amount of air flowing. A simple instrument for such use is the pitot tube, arranged as a differential gage, and so indicating velocity only. There will always be a flow if a velocity is indicated. And if pipe sizes are proportional to the volumes flowing, the velocities from each fan should be equal. If, therefore, the readings from the pitot tubes from the discharge sides of two or more fans are the same, it is quite certain that these fans are delivering their proportional amounts of air.

When fans of different sizes and speeds are connected to deliver air to the same main, the problem of their parallel operation becomes more complex, but is based on the same equality of total or dynamic heads.

Starting up an idle fan and putting it into the line is, of course, the troublesome part, for, until air is actually flowing through and away from the fan, it has no velocity head. If it can be speeded up so that its static head alone is equal to the static and velocity heads of the fans already in operation, then the higher static pressure will start the air flow and the speed must then be adjusted until the dynamic head is the same as that under which the other fans are running.

When the speed of the fan cannot be raised above that of the running fans, which is the more common condition of operation, then the dynamic head of the running fans must be reduced to equal that of the static head of the fan being put onto the line.

This operation, when there is more than one fan already running, is not an easy performance. Paralleling two fans is easy, but paralleling three is not. The usual type of inlet and discharge valve furnished by the makers is some form of butterfly valve or slide gate, and a fine adjustment of the former is a work of art. A pitot tube on the discharge side of each fan with the gages so connected that the operator may read all from one point seems to be the most desirable arrangement, when it is necessary to parallel fans.

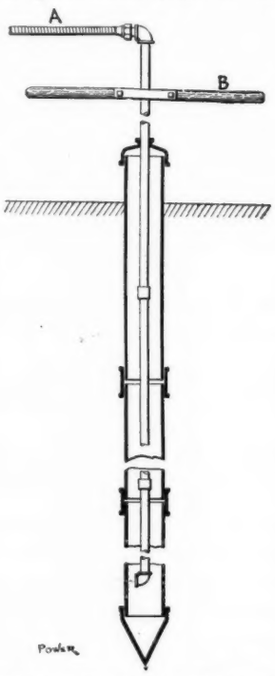
The usual method is to adjust inlet or discharge valves and it is sometimes necessary to move fast from one fan to another, to get the fans together and to keep them together after they are in.

When positive blowers or compressors are discharging into the same line, the conditions are quite different and, up to the limit of the possible discharge pressures developed, each machine will discharge its proportionate share of the air.

Cleaning Driven Wells

By J. B. Proctor

Much of the water used in our plant is obtained from 2-in. driven wells of depths from 45 to 60 ft. The screen or perforated pipe at the bottoms of these wells would clog up every five months and we at the plant had to remove the obstruction. The method of cleaning was to draw up the well pipe, put on new or old and clean screens and redrive the pipe. This was a troublesome and expensive operation.



Ready to Clean Driven Well by Steam

To lower the cost of cleaning and also reduce the consequent troubles, the writer devised the cleaning outfit shown. A ⅜-in. pipe longer than the well pipe and with an elbow on each end is connected to a steam pipe by the steam hose *A*. To the ⅜-in. pipe a wooden clamp *B* is fastened. A platform is located over the well to assist in putting in the ⅜-in. pipe. When the pipe is in place and the top of the well closed, steam at boiler pressure (100 lb.) is admitted to the pipe. The pipe is then raised, lowered and turned by men on the platform holding the clamp. The wells, after being cleaned, give nearly as much water as a new well.

Electricity to Operate the Panama Canal—The machinery for operating the gates, dams, fender chains, pumps, etc., will be electrically driven; the ships will be towed through the locks by powerful electric locomotives, and electric energy will be utilized entirely for the permanent machine shops, for the dry-dock, for the coal-handling plant, for wharf cranes, and for a number of other purposes. The locks and near-by towns will be electrically lighted, and the relocated Panama railroad will possibly be electrified. Two large power stations and many miles of transmission circuits will be required for the generation and transmission of the power to more than one thousand electric motors which will be required for the operation of the canal. The water power is obtained from the Chagres River water shed; Gatun Lake, having an area of 165 square miles, offering excellent storage facilities. A 7500-kw. hydro-electric generating station, which will supply the power under normal conditions, is being built at the spillway of the Gatun dam. The present steam-turbine station at Miraflores, which has been used during the construction of the canal, will, however, be retained and held in reserve to tide over either shutdowns or low-water periods of the Gatun station, the intention being to tie together the two plants by a high-tension transmission line. Besides the above, hydro-electric power will be extensively used for lighting purposes along the canal, and possibly in connection with the fortifications which are being planned.—"Engineering Magazine."

ELECTRICAL DEPARTMENT

The Induction Motor—V

By F. A. Annett

A motor constructed similar to the induction motor shown in Fig. 6, Part 1 (page 536, Oct. 14 issue) and provided with but one winding, if connected to a single-phase circuit, could only produce a simple alternating magnetism, and not a revolving magnetic field. The action would be similar to that of a transformer, the stator winding acting as the primary and the rotor acting as a short-circuited secondary; very heavy currents would be set up in the rotor, the primary taking a large lagging current from the line. The current in the rotor is of such a direction and position that the motor will develop very little torque, but if given a start by hand would gradually come up to speed in whichever direction it is started, then the load may be applied and the motor will behave similar to a two- or three-phase motor. As the speed of a single-phase motor approaches synchronism the combined action of the stator and rotor currents is to produce a rotating magnetic field similar to that produced in a motor with two or more windings supplied by two or more alternating currents displaced in phase. The most prominent difference between the single-phase and polyphase induction motors is the inability of the single-phase motor to start.

If a single-phase motor is to be made self-starting, some means must be provided for producing a revolving magnetic field, and for doing this numerous devices have been produced. In the design of single-phase fan motors and motors of similar size used for power purposes little trouble is experienced, but in large motors where efficiency and other operating characteristics are of primary importance the problem assumes a different aspect.

Shaded-Pole Motor

One of the simplest methods of producing a revolving magnetic field for bringing a single-phase motor up to speed is that which is known as the "shaded pole." The stator of this type is shown diagrammatically in Fig. 43. The field structure is built up of laminated iron with pole projections similar to a direct-current machine with a slot cut in the pole face parallel to the axis of the rotor, as shown in Fig. 44. This slot is sometimes cut through the center of the pole face and sometimes to one side. The field coils are similar to those in the direct-current machine and all are connected in series as shown. A rectangular copper stamping is placed around each pole tip in the slot, as shown in Fig. 44. In some cases this copper stamping is replaced by a number of turns of low-resistance wire, the two ends of the coil being joined to make a closed circuit; these are called shading coils. The rotor of this type of motor is a simple squirrel cage. The action of the copper stamping or shading coil is as follows:

If these field coils were connected to a single-phase circuit they would have a current set up in them first in one direction and then in the other. This alternating current sets up an alternating magnetic field through the field structure and rotor. The field coils will act similar to the primary of a transformer and the shading coils like the secondary. Since the shading coils are of very low resistance and short-circuited they will have heavy currents set up in them that will oppose the change in the magnetic flux set up by the main coils. Consider the current increasing in value through the coils in a direction so as to produce alternate north and south poles, as shown. As the current increases in value it will

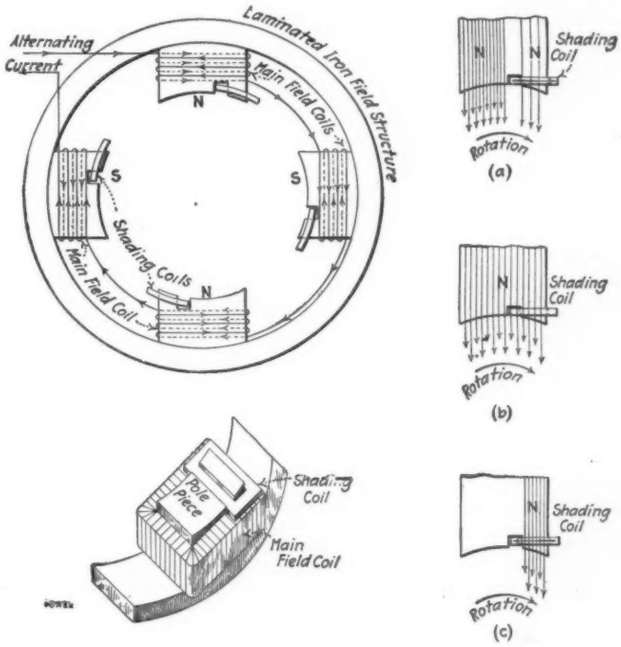


Fig. 43. Stator of Shaded-Pole Motor
Fig. 44. Detail of Shaded Pole
Fig. 45 (a), (b), (c). Flux Distribution Due to Shaded Pole

set up an increasing magnetic flux that will induce a current in the shading coils in opposition to the current in the main coils, as indicated by the arrow-heads. Therefore, the magnetomotive force produced by the shading coil will be in opposition to that produced by the primary coil. This will distort the flux away from the pole tips with the shading coil over to the opposite pole tip. Such a condition is represented in Fig. 45(a), but the flux will continue to increase through the pole tip with the shading coil until the exciting current has passed through a maximum and decreased to a point just sufficient to maintain the flux in the polepiece equal to that in the part surrounded by the shading coil. At this point the magnetic flux through the shading coil is at a maximum and the current in the shading coil is zero; Fig. 45(b) shows this condition. As the flux in the main part of the pole continues to decrease, the current in the shading coil reverses in direction and sets up a magnetomotive force

that tends to prevent any change of lines of force through the shading coil so that when there is no flux in the main part of the pole there will be considerable field within the shading coil, as shown in Fig. 45(c); therefore, the north pole has shifted from the main portion of the polepiece to that which is within the shading coil, likewise with the other poles. As the current in the line reverses north poles are interchanged with south. It will be seen that

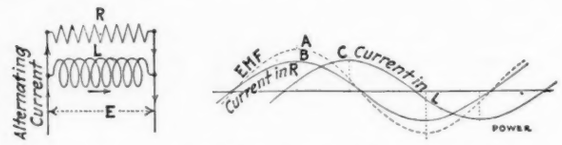


FIG. 46. ALTERNATING-CURRENT CIRCUIT WITH RESISTANCE AND INDUCTIVE REACTANCE

FIG. 47. RELATIVE VALUES OF CURRENT AND E.M.F.

the poles are continually shifting around in the direction of the shading coil, producing a truly revolving field. A rotor placed in this field would be carried around with it just as in a polyphase motor. This type of motor is used chiefly for fans and is usually built with four or six poles, although it may be constructed with any given number, depending upon the speed required. This motor does not operate satisfactorily in large sizes on account of its low efficiency, low starting torque and other operating characteristics.

From the foregoing it was seen that the rotor turns across the polepiece in the direction of the shading coils. To reverse the direction of rotation it will be necessary to place the shading coil on the opposite pole tips, but in some cases this cannot be done for the shading coils do not always pass through the center of the pole face. If the bearings are interchangeable the rotor may be turned end for end, this will be the same as turning the entire field structure around, which would bring the shading coils on the opposite side of the polepieces when viewed from the same end of the rotor as before. Where this cannot be done it will be necessary to remove the laminated field structure from its shell and place it in the opposite way.

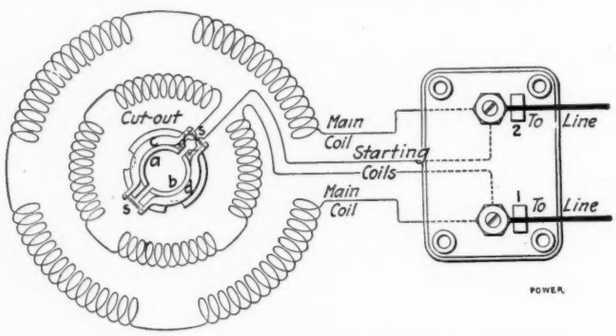


FIG. 48. REPRESENTING SPLIT-PHASE WINDINGS OF EMERSON MOTOR

SPLIT PHASE

Another method that is used in a great many different forms for starting single-phase motors is that which is known as phase splitting. It is well known that when an alternating current divides between two branches of a circuit of unequal resistance and reactance there is a phase difference between the currents in the two branches; that is, the current in one branch lags behind that in the other, depending upon the resistance and reactance in the two circuits. This condition is represented in Fig. 46, where R is a resistance of low reactance and L is an inductive reactance connected in parallel with R to a single-phase alternating-current circuit. Let the curve A, Fig. 47, represent the e.m.f. of the circuit. An alternating current will flow in the circuit R approximately in step with the impressed e.m.f. since the reactance of R is very low. Let this current be represented by the curve B. Since the reactance of L is high, an e.m.f. will be induced in it, which will oppose any change in the value of the current in the circuit, therefore the current will lag behind the applied e.m.f. and may be represented by the curve C. From this it will be seen that the current in circuit R is at a maximum when the current in L is at a low value and *vice versa;* therefore, the currents in R and L approach the condition of the currents in a two-phase

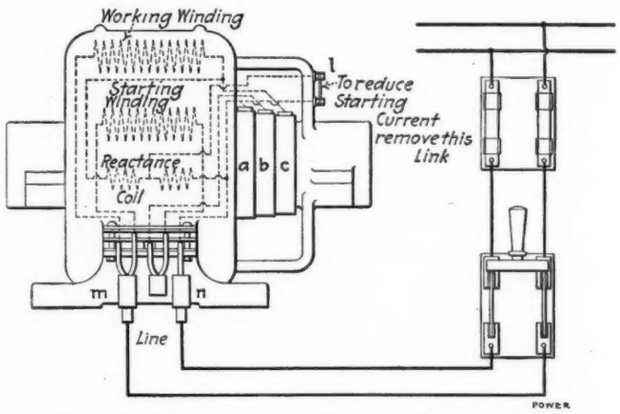


FIG. 49. WINDINGS OF HOLTZER-CABOT MOTOR

circuit which are 90 deg. apart and are represented by the curves in Fig. 5, Part 1 (page 535, Oct. 14, 1913, issue).

SPLIT-PHASE MOTOR

If an induction motor is constructed with two windings, one of high resistance and one of low resistance, these windings being spaced as in the two-phase motor, and the two windings connected in parallel to a single circuit, they will produce a revolving magnetic field as explained in Part 1. This type of motor is called a split-phase motor.

Fig. 48 represents the windings of an Emerson single-phase motor that is accelerated by the split-phase method. The main coils are made up of many turns of coarse wire which occupy about three-quarters of the stator slots, the two ends of which are connected direct to the line terminals. The starting winding which consists of many turns of fine wire occupies about one-quarter of the slots, one end of which is connected to the line terminal (1), and the other connected to the line terminal (2) through two segments *a* and *b*. These two parts are stationary and are mounted on the inner end of one of the bearing housings and are insulated from each other and their support. When the motor is at rest segments *a* and *b* are short-circuited by the semi-circular contacts *c* and *d* which are mounted on the rotor and held in contact with segments *a* and *b* by the springs *s*, as shown.

At starting, the conditions are similar to those explained for Fig. 47. The current in the main

winding lags farther behind the electromotive force than the current in the starting winding, thus producing an imperfect form of revolving magnetic field which gives the motor sufficient torque to bring it up to speed. When the rotor has reached about 75 per cent. full speed the contacts *c* and *d* are thrown off segments *a* and *b* by centrifugal force. This leaves the starting winding open

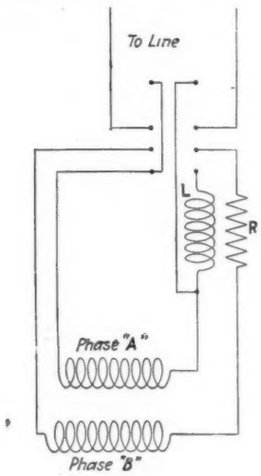


FIG. 50.

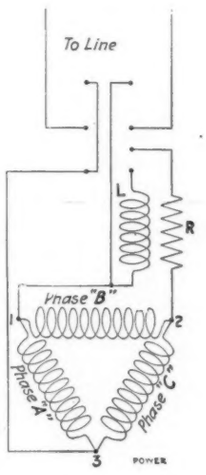


FIG. 51.

METHOD OF STARTING TWO- AND THREE-PHASE MOTORS

circuited, and the motor operates on the main winding. If the motor is to be started under load the rotor is arranged to revolve freely on the shaft. When it has attained about 85 or 90 per cent. normal speed the shaft and rotor are locked together by a clutch, in this way these motors are enabled to start under full load. To reverse the direction of rotation cross either the leads of the starting or running winding. This type of single-phase motor is built by several electrical manufacturers.

Fig. 49 shows diagrammatically a Holtzer-Cabot split-phase motor that is built in sizes from 1 to 5 hp. In addition to the main and starting windings, as already referred to, an additional external inductive reactance, mounted in the base of the motor frame, is connected in series with the main or working winding at starting. This reactance causes a greater phase displacement between the currents in the starting and main windings with a corresponding increase in starting torque. This type of motor will start under full load without any automatic rotor clutch. Three slip rings *a*, *b* and *c*, which are insulated from each other, are mounted on the rotor shaft through which the main end starting windings are connected by brushes. At starting, slip rings *a* and *b* are connected together through a switch in the rotor. This allows the current from the line to flow from terminal *m* through the working winding and the reactance coils to the opposite terminal *n* of the line, also from terminal *m* through the starting winding and the slip rings *a* and *b* to the line terminal *n*. When the motor has attained about 80 per cent. full-load speed the centrifugal switch opens the circuit between slip rings *a* and *b* and closes that between slip rings *a* and *c*. This cuts out the starting winding and short-circuits the reactance coils; then the main winding is connected direct to the line. When necessary a link *l* is used to short-circuit one section of the reactance. This allows the motor to take a larger starting current from the line which increases the starting torque. In sizes of less than 1 hp. the reactance coils are disposed with and only two slip rings are used which are radial and are mounted against the end of the rotor with brushes that are parallel with the shaft.

POLYPHASE MOTORS ON SINGLE-PHASE CIRCUIT

A two-phase motor will start when the currents in the two stator windings are less than 90 deg. apart, likewise a three-phase motor will start when the three currents in the three stator windings have a phase displacement other than 120 deg., although the starting torque becomes less and less as the phase displacement changes. Two-phase motors may be started on a single-phase circuit by connecting a resistance or an inductive reactance in series with either phase. This method can be improved by connecting a resistance in series with one phase and a reactance in series with the other phase. Fig. 50 shows the connections for doing this through a double-pole double-throw switch. When the switch is in the down position a reactance *L* is connected in series with phase *A* and a resistance *R* in series with phase *B*. The reactance *L* increases the phase displacement between the e.m.f. and the current in phase *A*, while the resistance *R* decreases the phase displacement between the e.m.f. and the current in phase *B*, thus causing a phase displacement between the current in phases *A* and *B* and producing an imperfect form of revolving magnetic field which will develop sufficient torque to bring the motor up to speed. Then the switch may be thrown to the up position, which connects phase *A* direct to the line and phase *B* is cut out of circuit.

A three-phase motor may be brought up to speed on a single-phase circuit by connecting two of the motor terminals to one side of the line through a resistance and reactance and the third terminal direct to the line. Fig. 51 shows the connections for doing this through a double-pole double-throw switch. When the switch is in the down position the motor terminals 1 and 2 are connected

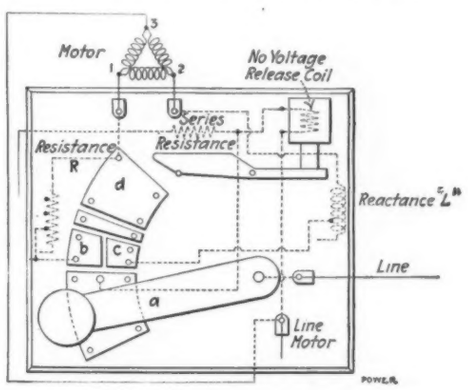


FIG. 52. G. E. STARTER

to the same side of the line through a resistance *R* and reactance *L* respectively, and terminal 3 is connected direct to the line. This gives a phase displacement to the current in the three stator windings which is sufficient to start the motor under no load. After the motor has been brought up to speed the switch is thrown to the up position, thus cutting out the resistance and reactance and connecting terminals 1 and 3 direct to the line; then the motor is operating as a single-phase motor and the load may be applied. A three-phase motor operating un-

der this condition will only have about two-thirds the capacity of its three-phase rating and has its maximum starting torque when the starting resistance and reactance are equal.

The General Electric Co. builds a single-phase motor which is started by the foregoing method. The starting resistance and reactance are mounted in a suitable starting box, shown in Fig. 52, connected to the stator windings which are connected in delta and are the same as in a regular three-phase motor. At starting the arm *a* is raised to a position so as to rest on contacts *b* and *c*. This connects the motor to the line through the resistance *R* and reactance *L* which is the same condition as in Fig. 51. After the motor has attained the proper speed, arm *a* is raised to position *d* and is held in this position by the no-voltage release coil. Arm *a* is made interlocking in such a way that when it is raised to the starting position it cannot be raised any farther until first dropped back slightly to release the lock and then raised quickly to the running position. This prevents the attendant from raising the arm to the running position before the motor has had time to accelerate. The rotor is of the regular squirrel-cage type and is arranged so that at starting it revolves freely on the shaft. After attaining approximately full speed the rotor is locked to the shaft by means of an automatic clutch. These motors are built in sizes from ¼ to 15 hp. The 10- to 15-hp. starters are provided with taps on the starting resistance and reactance so that the starting torque can be changed.

❋

System of Tallying Truck Loads

By Ernest Giles

Counting truck loads of wood in the grinding room of a pulp mill, although a simple task, involves the personal element so much that the figures are seldom reliable and as production is checked against the amount of wood ground it is necessary to have an accurate count. There is at present being installed in a mill in northern New York a system of counting loads that is novel and at the same time simple, but above all practically fool proof, and will wipe out the personal element which has always been unreliable in the past. This system, although designed primarily for a pulp mill, could be used for other purposes, such as carloads of coal.

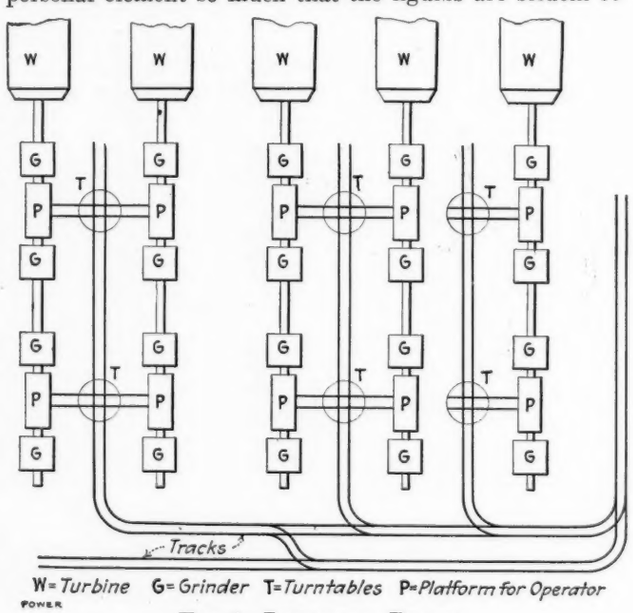


Fig. 1. Layout of Plant

The mill of which I write has 20 grinders, one grinderman taking care of two grinders, and working on eight-hour shifts. It is desired to know not only how many cords of wood are ground but how many each man grinds.

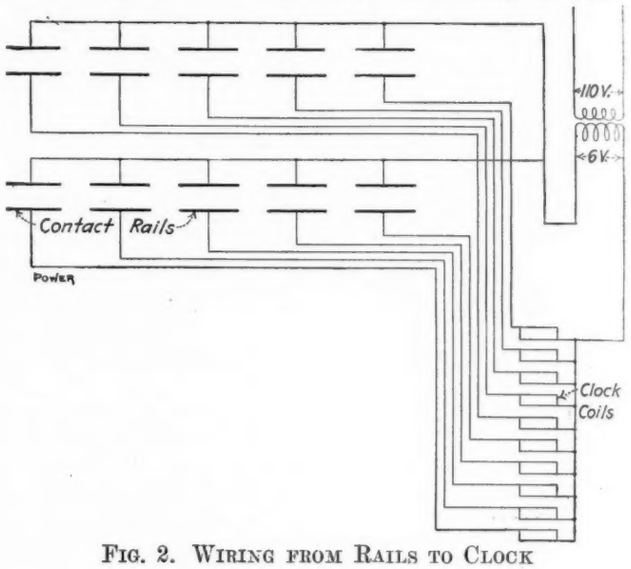


Fig. 2. Wiring from Rails to Clock

The grinder room is laid out as shown in Fig. 1 and is equipped with a system of rails and turntables going to all grinders. Wood is loaded onto trucks holding one-half cord and is pushed over the rails onto the turntables and turned directly onto a short siding, where the operator handles the two grinders.

The short rails at the sidings are insulated from the turntables and from each other, and form the two sides of an electric circuit which is closed by the wheels of the truck, thereby furnishing an excellent way of telling not only the time at which a load arrives but also how long it stays there and how soon a new load is placed.

Electricity for energizing the rails is supplied by a small specially designed transformer giving six volts at the secondary winding, this voltage having been decided on after a series of tests under working conditions.

All wiring is in conduit and is run under the floor in ducts, and the connections to the rails are made from below for protection. The wire used is standard No. 14 rubber covered, and is installed with the same degree of care as if it were used for lighting or power service.

The recording clock used follows standard practice in the arrangement of chart and pens, but is designed especially for use on low-frequency alternating current and uses solenoids for working the pens in place of ordinary magnets. Tests proved that magnets, as ordinarily built, gave a chattering movement of the pens unless very carefully adjusted, and any attempt to make the movement of the return to the position of rest (power off) positive, made the chattering worse, as the pens would necessarily be returned by spring pressure. However, the chattering was entirely overcome by using solenoids, the cores of which are so arranged as not to produce any movement of the pens other than to draw them over the chart and hold them there as long as the current is on the coils.

Reference to Fig. 2 will show the wiring scheme, which is the same as that used on an ordinary annunciator.

HEATING AND VENTILATION

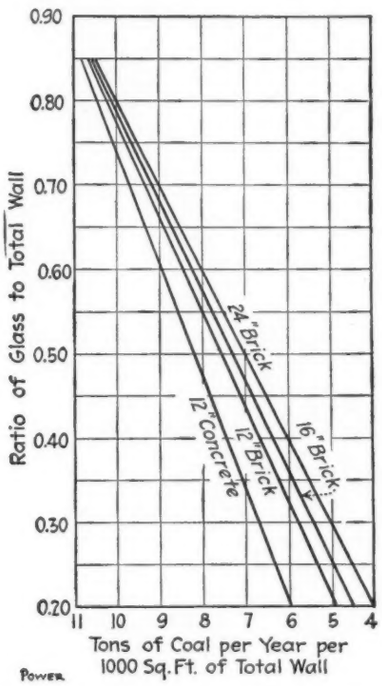
Coal to Heat Factory Buildings

By James D. White

There are various opinions as to the relative merits of the isolated plant and the central station. It is not the intention of the writer to take sides in this matter but rather to present some facts regarding the fuel requirements of factory buildings which may be of use in forming an opinion for any particular case.

Accurate information as to the power required for a plant is generally available. It is just as necessary to know the amount of steam required for heating, but information on this point is usually lacking.

About 80 per cent. of the heat of the steam at the



Coal per Season for Different Thicknesses of Wall

pressure of the exhaust is available for heating. Knowing the pounds of steam required per hour to drive the engine in any plant it is easy to calculate the amount remaining for heating.

For the conditions found in the New England States about 65 lb. of coal are required per square foot of direct radiation for the heating season. Buildings heated by the fan system will vary in their fuel requirements from those heated by direct radiation, depending on the amount of air supplied from the outside.

The curves accompanying this article are based on standard factory construction. An amount of radiation is provided to heat the buildings to 65 deg. in zero weather. Values are given for buildings with 12-, 16- and 24-in. brick and 12-in. concrete walls.

The term "equivalent roof" is defined as a square foot of roof surface with the same transmission rate as a square foot of wall surface. A large majority of factory buildings are covered with a tar and gravel roof on 2-in. plank. In this case, 1 sq.ft. of roof equals 1 sq.ft. of 12-in. brick, 1.21 sq.ft. of 16-in. brick, 1.57 sq.ft. of 24-in. brick and 0.70 sq.ft. of 12-in. concrete. For roofs covered with slate or tile, suitable allowances should be made.

Reduce the square feet of roof surface to an equivalent number of square feet of wall surface having the same transmission in B.t.u. per hour. Add this result to the square feet of vertical wall to obtain the total wall surface. Walls adjacent to a heated building should be omitted as there will be no transfer of heat through them. Find the ratio between the square feet of glass surface and the square feet of total wall surface for the building under consideration. At the point where this line intersects the curve for a given thickness of wall surface drop a vertical to the lowest horizontal line of the chart and read tons of coal per year for 1000 sq.ft. of wall surface.

In case there are several thicknesses of wall in the same building, find the values for each different thickness and combine the results. It is evident that buildings with little leakage or those having an automatic system of temperature control will use less fuel than the average value previously given. On the other hand, buildings with large doors which are open to transfer manufactured products will require more fuel than would be indicated by the curves. In such cases good judgment will be required to modify the values given.

It is the desire of the writer that engineers having accurate data on the fuel requirements of their own buildings will compare their results with the method given above. Particular attention should be paid to any special features of the plant that would tend to show the reasons for the difference in values. In this way much valuable information may be given regarding a subject that at the present time is more or less in doubt.

❖

A Combination Steam and Hot-Water Heating System

By A. P. Connor

There are many occasions arising in daily practice, where a combination steam and hot-water system using the same piping and the same heating medium is not only mechanically desirable but would increase the efficiency of the plant. Such a system can be readily adopted in many installations without involving appreciable labor or cost, as was done in the case to be described.

In the particular instance which the writer has in mind, a steam main ran from the power house to a series of buildings, over 1000 ft. away, and supplied heat for various purposes and in various degrees. The method originally employed was to use live steam and exhaust into the sewer, the radiation in the various buildings be-

ing proportioned to its heating requirements and controlled by valves. This system was satisfactory as far as heating was concerned, but the amount of steam rising out of the sewer manholes in the vicinity of the discharge from the heating system of these buildings made an undesirable spectacle in addition to the waste of energy. The engineer in charge, who it may be said was not responsible for the original layout, decided something had to be done, and that without any outlay because no funds were available.

On investigation he found the following situation: As shown in Fig. 1, the steam mains to the buildings near the end of the lines were run close to the ceilings and dropped to the radiation in the buildings in series, thence going through a steam trap to the sewer. The water sent through the trap being hot, created a lot of vapor in the sewer which came out through the various manholes and was especially conspicuous on damp or cold days.

The trouble was remedied by procuring a tank, inserting it horizontally in the steam line close to the ceiling and connecting a steam trap, as shown in Fig. 2. The steam trap collected the water from the heating system

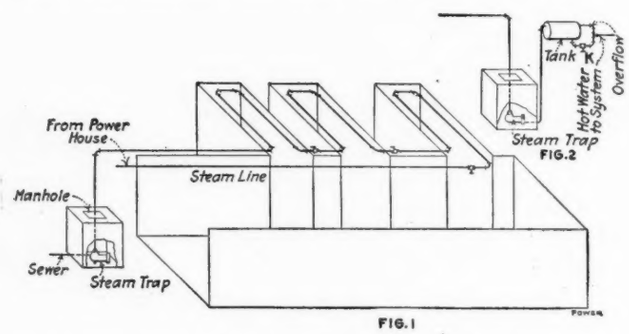


FIG. 2

FIG. 1

up to that point and when operated raised the water to the tank in the steam mains, a head of about 12 ft. The water was allowed to collect in the tank until it was several inches deep, and then the operator turned on the valve *K* just sufficiently to let a uniform and constant quantity of water into the system beyond the tank. Sufficient hot water was supplied to keep the system at a desirable temperature and the head given by the position of the tank produced a positive flow. The valve at the end of the line was opened to let the water into the sewer in the same proportion as the hot water entered. An overflow pipe was also provided on the tank to act in case the valve got stopped up or did not let water flow through in sufficient quantity.

The water in the first building heated by hot water was at the boiling point to begin with and the general temperature of the building was high. The next building was heated to the desired temperature but the average temperature of the water was about 60 deg. lower than in the first building. In the third building the temperature of the water was still lower and on leaving the system was barely warm. This eliminated the vapor trouble originally experienced.

It is needless to add that the efficiency of the system was increased, and no difficulties of note were experienced in its operation. The cost of making the changes was practically nothing, owing to the fact that a tank was available at the time, the fittings were in stock and the regular employees of the plant did the work. It may be added that later on all of the water was returned to the boilers by means of a pump. A suitable length of 1½-in. pipe was run underground and a slight change made in the connections at the sewer.

The results produced by these later changes were a saving in water, an elimination of boiler-scale troubles and oxidization, and an appreciable saving in coal. The steam-hot-water combination has been used a number of years and is still in daily service.

Cost of Heating and Power-Plant Apparatus

The article by W. J. Downing in the Nov. 18 issue of POWER under the above title contains much useful information. While most of it appeals to the writer as being sufficiently accurate for estimating probable costs, yet some of the items are excessively high and might deter an embryo designer from using the apparatus considered. Thus under the heading "Radiation," pipe-coil heaters for fan systems are estimated at 45 to 50c. per sq.ft. of surface. In my experience this should be from 24 to 45c. per sq.ft. of surface. This price includes the complete casing and fan connections, the low price being for coils about 7x10 ft. and the higher prices of coils down to 3x6 ft. Now the designer using Mr. Downing's figures would be justified in using cast-iron heaters exclusively at 25c. per ft., although as a matter of fact under certain conditions pipe coils are a better proposition.

Shaking grates instead of costing $5 to $6 per sq.ft. of surface, can be installed for from $3.75 to $4.75 per sq.ft. Open feed-water heaters, good for 10-lb. pressure, complete with oil separator and grease trap, can be bought for about $1 per horsepower as low as the 400-hp. size, and for 75c. per hp. in the 1000-hp. size.

Under the heading "Ventilating Apparatus," steel-plate fans are estimated at $10 to $13 per 1000 cu.ft. at ¾ oz. pressure. This again is far too liberal, $7 to $10 being quite safe.

Galvanized-iron work is estimated at 15c. per lb., which is excessive for average factory work, as 10c. per lb. in place will cover a first-class job where local help can be used. Only recently we let a 5-ton job at about 6c. per lb., but we realize that this is an exceptionally low figure.

Electric-light wiring is estimated at $6 per outlet. For dwellings this is too high, $2 per outlet is a safe figure.

All the prices given by the writer are based on actual quotations given this year and so are perfectly reliable.

In his article, which was short, considering the ground covered, Mr. Downing could not go into details as to what was included in his prices. This may account for the difference between his figures and mine. However, the difference is great enough to warrant attention being called to the fact that in several cases Mr. Downing's estimates are too liberal and thus misleading. They would be even more liberal if the contractor's 10 per cent. were included, as it is in the writer's quotations.

Syracuse, N. Y. A. ROBERTSON.

Remuneration of Electrical Engineers—Anyone who keeps closely in touch with the developments in al branches of the electrical industry cannot fail to be an optimist regarding its future. This is the age of electricity. The demand for men trained to make available its beneficient powers for the service of society is bound to increase. For the best results of all a healthy balance of the demand and supply of men so trained is needed.—"Electrical Review."

EDITORIALS

The Elevation of the Fireman

For years the steam engineer has made the engine room the locus of his activities, and the engine the principal object of his solicitude. Even here the selection has too often been determined by the expected performance of the engine in pounds of steam per unit of output rather than the ultimate economy of the plant expressed in money per unit of production as influenced by the standing charges, use-factor, etc., but that is another story. What we want to emphasize now is the still persisting proclivity to direct one's efforts for betterment to the limited possibilities of the engine room; while the conditions and operation of the boiler room, rich in possibilities of saving beyond anything which continuous effort in the engine room can possibly effect, receive but desultory attention and are left in the hands of the poorest paid and least intelligent of the operating force.

When the engines have been selected, their valves properly set, and provision made for their proper lubrication the exercise of effective supervision is confined to an intelligent adaptation of units to load and to the keeping of the engines in proper condition with regard to packing, valve setting, etc. There is little that one can do in the engine room beyond this that will have any bearing on the cost of the power produced. In the boiler room the conditions are quite otherwise. The most effective normal condition is more difficult to arrive at, and once determined upon is more difficult to maintain. Adjustments instead of being good for months are good for minutes, and a high degree of skill must be constantly applied to conduct the process of converting the energy latent in the fuel into a form in which it is available for power production.

In this part of the plant more than anywhere else the human factor is predominant. Months of study and thousands of dollars of investment are expended upon the efficiency of the engines and apparatus, but how much attention is given to the efficiency of the men?

The process of combustion is a complicated and interesting chemical one. A man who understands it and applies his knowledge may easily do the same work on ten per cent. less fuel, and save twice his wages, while a man in responsible charge of the whole steam-generating plant may easily raise its efficiency from the usual sixty to seventy-five or eighty per cent.

The trouble has been that men with the education, ability and spirit which would make them successful in this work will not work under the conditions of the ordinary boiler room, nor for the money which the ordinary owner or manager is willing to pay for what he has been accustomed to regard as a laborer's job.

With the increasing estimate of the possibilities of saving which the boiler room offers, the lightening of the manual labor by means of conveying machinery and mechanical stokers, the increased interest which comes from the scientific study of the boiler-room processes, the use of instruments requiring as high a degree of skill at least as any used in the engine room, it is reasonable to suppose that the time is near at hand when the management of the fire room will pass out of the hands of the illiterate stoker, and will attract a higher order of man, who will find nothing undignified in applying his knowledge of boilers and furnaces, and baffles, and rates of combustion, and flue gas, coal and ash analysis, to saving a quarter of the coal which is burned in the big plant, and that he will receive a remuneration commensurate with the service which he renders and the saving which he effects.

The papers of J. W. Parker, of the Detroit Edison Co., upon "The Operation of the Large Boiler Units at the Delray Station" of that company and especially that of Prof. Walter N. Polakov upon "Task Setting for Firemen," both read at the recent meeting of the American Society of Mechanical Engineers, are replete with suggestions of the possibilities which lie in this direction.

Substitutes in Emergencies

Continuous service is the prime consideration in any power plant, large or small. Economical operation is secondary to continuous service.

Power-plant apparatus is subject to disorders even when reasonably well cared for, but let the attentiveness of the operator become lax and the liability to accidents productive of service interruptions becomes proportionally greater. Not long ago one of our engineer friends related with justifiable pride how the central-station plant he had operated had not, in nine years, suffered a service interruption that was due to disorders of apparatus or machinery inside the power house. He attributed this to the frequent and thorough inspections given equipment and to the practice of lifting by hand each safety valve and of inspecting the turbine emergency stop just prior to the peak-load periods, which come in the late afternoons. It is this unfailing attention to detail that reduces emergencies to a minimum.

Despite the most careful observation and inspection of equipment, conditions arise that make it impossible to operate the plant without resorting to unusual measures. It is the ability, the resourcefulness, to meet such conditions that makes a man valuable.

We recall the case of a plant in Baltimore which made use of the boilers in a large steamboat to furnish steam when its own were suddenly put out of service. A contemporary criticized the authorities of the Richmond Light & Power Co. for not making use of a similar expedient when its plant was out of service for five days, due to a boiler explosion. Perhaps no one in authority thought of this substitute. This is not a good excuse, however, for the Baltimore incident received adequate publicity.

During the floods in the Middle West last spring many interesting emergencies arose. One plant was unfortunate enough to have the motor driving the condenser-hot-

well pump completely disabled. To operate the turbine noncondensing would have meant using all the coal in the bunkers in a few days, with no indication of getting more, as over a 1000 ft. of the railroad siding to the plant was washed away. The dry-air pump was made to handle the condensed steam as well as the noncondensible vapors. And it did so for ten days, in which time the siding was repaired, the bunkers filled and the hotwell pump again available.

The art of autogenous welding is doing much to insure continuous service when interruptions seem imminent, due to equipment being cracked and broken.

Hardwood has been used to make substitute parts for broken cylinder heads, piston rings, rocker-arms, etc., and these parts have given service until the arrival of metal parts. In substituting wooden for iron or steel parts, care must, of course, be taken to make them strong enough to meet conditions or make conditions suit the strength of the parts. The thing to remember is that parts of equipment as designed and built are the best, though not necessarily the only, means of accomplishing the function of the particular apparatus.

Refrigeration and Central-Station Power

With the advent of raw-water ice which does not call for the installation of evaporators, the central station has been waking to the possibilities of a refrigerating or ice-making load. The characteristics of such plants are to their liking and help to boost their annual load factor at the period during which they carry the lightest load of the year. Starting with the month of January their load is high and continues so during the winter months. During the spring and summer there is a great falling off and the load does not begin to pick up until the month of October. From then on there is a gradual rise and in December the average central station is carrying the heaviest load of the year. Machinery must, of course, be installed to supply the heaviest draft on the station and part of it must remain inactive or at least "run light" when the demands are a minimum.

To fill up this valley in their annual load curve has been the concentrated aim of the central station, and the same may be said of the daily load which in most stations runs high in the morning and evening hours. For this very purpose there is no load better adapted than a refrigerating or ice-making plant, and especially the latter when not equipped with storage. In the average ice plant on which there is no special call for ice outside of the usual public demand, over sixty per cent. of the annual output is sold in the months of June, July, August and September. The balance is distributed over the eight months remaining. Even with storage when a uniform load is carried throughout the year there is the possibility, with large brine storage to maintain the temperature, of shutting down during the highest part of the daily peak. Refrigeration would furnish a load having ice-plant characteristics, although, perhaps, the division of the annual power requirements would be slightly different. In either case the load would be continuous and approximately uniform for twenty-four hours in the day.

It is small wonder then that central stations desire such a load and in some cases at least are offering rates much lower than they would give for the same amount of power to other consumers of energy. According to their logic, as expressed by one of their representatives at a recent convention, they can afford to dispense with the fixed charges and make a very small profit over the operating costs. It has probably occurred to them that this policy is unfair to the small light and power users, who in most cases absorb the greater part of the load. They know it is discrimination pure and simple, but the public stands for it, and besides it betters their annual load factor and the gross receipts.

It is apparent, however, that their operating cost or perhaps their profit is too high, for they have made very little headway in serving plants of over twenty-five tons capacity. There are a few exceptions, such as a plant in Brooklyn of one hundred and fifty tons capacity, which by a specially low rate has been drawn into the fold. Even in this special case it is not at all certain that an isolated plant could not do better. There are cases where power should be purchased, but these are the small plants previously cited. For a plant of any pretensions the rate must be low indeed—in fact, away below what the central station could possibly give without discriminating heavily against a large proportion of its customers—to discount the results obtained in an isolated plant properly managed and operated with fair economy.

It will be admitted that the generating cost of power in the central station is slightly lower than in the average isolated plant, but in the formation of rates the dispensers of power are under a heavy handicap caused by an expensive office and selling force, transmission losses to the service, the possibilities of using exhaust steam for heating and high overhead charges due to the enormous investment required. Then profits must be considered and in the past there has been more or less trouble in transmitting the power from a motor to the compressor shaft.

If all these items are considered and included in the rate, the central station could not possibly compete with an efficient isolated plant of sufficient capacity to produce average results. If the rates are based on operating and transmission costs only and the other consumers are forced to pay all of the fixed charges, the competition would be much closer. Even then the rate must be exceptionally low or the steam plant should rule the favorite, and if we can believe all we hear about oil engines there would be no chance at all for the central station.

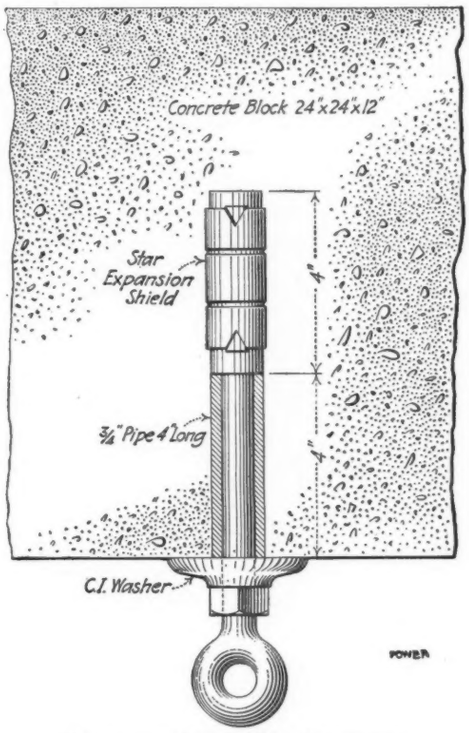
The "dense smoke" nuisance in New York City again looms ominous on the horizon. The Appellate Division of the Supreme Court directs that impending cases be investigated and proceeded with. It was only last summer that the smoke ordinance was declared "unreasonable and unconstitutional" by three judges. Some day in a future remote, when the coal supply is exhausted and there is nothing to produce smoke, New Yorkers will create an excellent smoke-inspection department. In the meanwhile bring on the soft coal; let furnace design go where it will! Let judges and health officers wrangle in the ever thickening smudge. We should worry!

The index of POWER for the second half for 1913, Volume 38, will be ready early in January, and will be sent without charge only to those requesting it.

READERS WITH SOMETHING TO SAY

Test of Expansion-Bolt Shield

Desiring to put an I-beam trolley under the power house to take out the draft tubes on the exciter units, and as the roof of the bays was 20 in. of concrete, five years old and heavily reinforced, drilling holes for six bolts would be no little task. Besides, the wheel casings



How the Bolt Was Inserted

would prevent getting bolts at the ends of the beam, next the tubes. So I determined to test a ¾-in. Star double-expansion shield for machine bolts.

I used a block of concrete 24x24x12 in. It was five years old, not reinforced, and was made of Ideal cement, one part to six of sand and gravel. A hole was drilled into the block 8 in. and of a size to allow the shield to slip in, care being taken in having the hole round and straight. The shield was placed at the bottom of the hole, and a piece of ¾-in. pipe just long enough to come flush with the face of the concrete placed on top. A ¾-in. I-bolt, made of common mild steel stock, standard ten V-thread, with a shoulder just under the eye and a washer on this shoulder, was screwed into the shield; the washer pressed against the end of the pipe and the face of the concrete, and the bolt was forced up until the shield had expanded.

The block was placed on a scaffold, and a platform suspended to the I-bolt by means of chains. The platform was loaded with pig tin, lead, babbitt, lava rock and heavy scrap iron until the chain gave way, a link being defective. Weighing the load, we found it to be 6181 lb.

As this was five and seven-eighths times the weight of the tube to be removed, and as we intended to use six bolts and shields to carry the trolley, we deemed the test sufficient. Examination of the bolt previous to loading on the last 400 or 500 lb. before the chain gave way, showed that the bolt gave no sign of loosening. After the load was removed, the shield was taken out. It showed only a slight contorsion at the lower or threaded end.

I think power-house men will find these expansion shields very useful for putting up small trolleys, I-bolts, or mounting brackets on the wall, anchoring down motors, etc., but care must be taken not to drill holes too large, and to have them round, and if possible twice the depth of the shield; and a piece of pipe should be used between the shield and the shoulder on the bolt, unless the shield comes flush with the face of the concrete, in which case the end of the shield will rest against the shoulder.

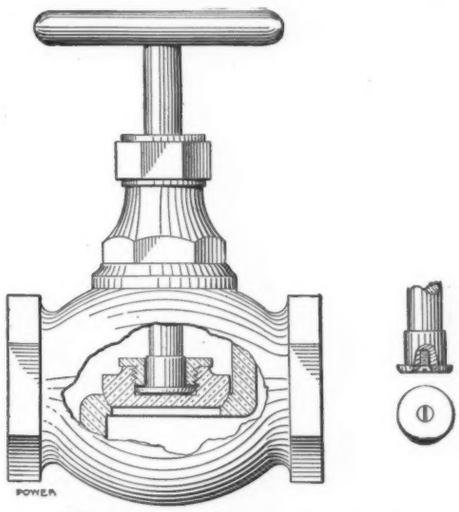
Ira F. Johnson.

Minidoka, Idaho.

Valve-Spindle Repair

A 1½-in. valve in one of the departments of our plant had been leaking badly for some time, and no report of it made. The valve was situated on the horizontal with steam on top of the brass disk.

One morning on opening the valve, steam would not flow through. After investigating I found that the brass



Valve and Details of Stem

disk had dropped off the spindle and the head of the spindle was worn down and twisted off as indicated by the arrows in Fig. 1.

Exerting too great a pressure on the handwheel to bring the disk tight on the seat to prevent it from leaking, resulted in this trouble. I found a piece of plate brass ⅛ in. thick, filed it round as possible, then drilled the hole in the center and countersunk it for a flat-headed machine screw. The spindle was then placed in the lathe and ⅛ in. taken off the end. I next drilled and

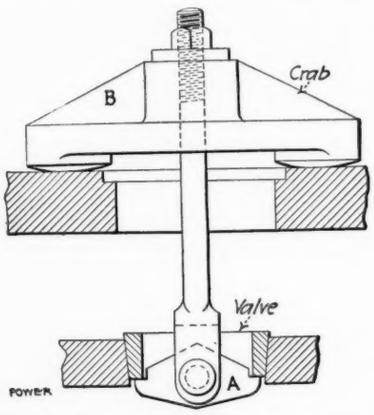
tapped a hole in the center for an $^{8}/_{32}$-thread machine screw. After putting the piece of brass plate on it was as shown in Fig. 2. The job was finished in about ten minutes.

FREDERICK L. JOHNSON.

Paterson, N. J.

Device for Removing Pump-Valve Seats

The device shown herewith is useful and saves trouble in removing valve seats from the valve plate of pumps. When it is desired to remove a seat the pull bolt is placed



PUMP-SEAT REMOVER IN PLACE

in position with the head *A*, which swivels, under the seat. The crab *B* which holds down the valve cap can be used as a bar when screwing up the nut, although any bar with a hole in the center will answer the purpose. The nut is screwed down on the pull bolt and the seat will readily come out. The head *A* can be made to fit any size seat.

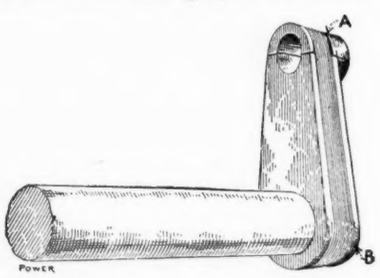
This device can also be used for removing water-cylinder sleeve by making the head *D* larger to suit.

W. WOLFGANG.

Toledo, Ohio.

Broken Crank Repaired with Wire

The valve-stem crank of a cold-brine pump broke through the crankpin bore. As shown the casting about the upper half of the crankpin fell entirely off. It broke about 11 o'clock at night, and as there was no machine shop open at that time of night, it was necessary to make



WIRE HOLDING BROKEN CRANK

a quick repair to hold the temperature in the freezer rooms.

Slots *A* and *B* were filed in the small and large ends of the crank. The pin was placed in position, the broken part placed over it and fine steel wire was then wound around the crank until the slots were filled. Over this fine wire one round of large copper wire was placed to hold the fine wire as the steel wire would break when attempting to tighten by twisting it. The pump has been operating for several days, the wire remaining in position.

G. A. ROBERTSON.

Louisville, Ky.

Firebrick Specifications

The following firebrick specifications are in use by the writer and are here given for the benefit of the profession. I trust that there may be some discussion of them, as, no doubt, all will not agree with the methods of construction. Anyone who has to be responsible for firebrick construction knows what a task it is to get good brick and have them laid up right:

FIREBRICK WORK—All firebrick shall be protected from moisture, and shall be dry when used. Each brick shall be dipped in a thin fine clay wash, rubbed and shoved into its final place, and then tapped with a wooden mallet until it actually touches the brick below it. The use of clay thick enough to lay with a trowel will not be permitted.

The walls of fire and red brick shall be carried up together. Furnace linings shall be laid four courses of headers and then one stretcher backed by a firebrick header. Furnace center walls shall be solid firebrick. Walls with 4½-in. linings or all red brick walls shall be laid with each header course on the inside of the wall lapping over a header course in the center of the wall, which in turn laps above a header course on the outside.

FIREBRICK ARCHES—If fire arches are called for by the drawings, the skewbacks shall be laid off parallel and at the same height with a straight-edge as long as the arch. The skew shall be a true surface, cut only on the ends of the brick. There shall be firebrick back to the buckstays on single settings, and entirely through the center wall on battery settings.

Batten strips for the arch centers shall not be more than 2 in. wide. Selected brick only, smooth, straight and uniform, shall be used in the arches. Brick shall be laid dry without any clay; and shall be shoved together close and tapped with a wooden mallet on the flat side only of the brick. They shall be laid in courses along the arch center, beginning at the rear end of the arch, not in rings, and with every joint broken, and with a bond equal to one-half of the brick. The first course shall start at the skewback on each side with a standard brick 4½ in. wide; the second at each side with a "flat back" 6½ in. wide; the third course 4½ in. and so on. To finish the courses at the front wall, a "flat back," cut to suit when necessary, shall be used. Each course shall be tried in place dry, and shall be checked with a straight-edge to insure all the brick of one course being the same thickness. Bricks not of even thickness must be cut and rubbed. A course of wedges shall be used only when necessary to keep the bottoms of the straight brick in even contact with the arch center. If the use of wedges does in every case bring a straight brick to an even bottom the straight brick should lean away from the center of the furnace rather than toward it. A trial ring shall be laid, when about two-thirds of the arch has been completed, to determine if the keying course will fit. If cutting is

necessary to fit the keying course, the key brick shall not be cut, but instead, the two adjacent courses on the side of the brick away from the key. The keying course shall be a true fit from top to bottom, of such thickness that when driven it shall not be below the surface of the arch, and shall preferably stand about ¼ in. above it. The keys should drive from 1 to 2½ in.

After fitting, the keys shall be loosely replaced, and then with a piece of wood, at least 2x4 in., extending the full length of the keying course, shall be driven uniformly to place with a heavy hammer, used along the entire length of the timber. After driving, the keys shall not show any crushing. When keyed up the top of the arch shall be thoroughly washed with a thin fireclay wash.

Centers shall be built so that they can be dropped down free of the arch after it is keyed, and removed from the setting without being burned out.

FREDERICK L. RAY.

Louisville, Ky.

Cause of Flywheel Explosions

Sometime ago I viewed the wreckage of a burst flywheel of a Corliss engine. The engine, doubtless, ran away, but as to the cause there was a difference of opinion.

Evidently the start of the wreck was in the bursting of a driven pulley that was either too light for the work or was cracked, when a sudden load was thrown on it. The chief engineer claimed a piece of this pulley disabled the governor, which allowed the engine to run away, thus bursting the flywheel, but the only damage done to the governor was the breaking of both the reach-rods running to the cam collars.

The chief engineer's opinion seemed to be correct, until hearing the story of the engineer immediately in charge of the engine in question.

The running engineer said he was about 50 ft. from the engine when he heard a loud report and saw the driven pulley broken, and the drive belt flopping. He ran to the engine, which by this time was going so fast it seemed to him impossible for the valves to pick up, and was in the act of closing the throttle when the governor rods, previously mentioned, flew up and struck him in the face. The bursting of the wheel following in quick succession, after which he knew nothing until restored to consciousness some time afterward.

The governor was all right when he got to the engine, and as the rods were the only parts of the governor damaged, it seems the broken pulley did not interfere with it at all. This placed the adjustments of the governor in a bad light, which subsequent inspection verified.

The knockoff cams were sheared off and the stop-collar, or collar that limits the upward travel of the governor sleeve, as well as the sleeve also, were up to the top connections of the governor arms. The piston of the gag-pot was lifted out of the cylinder. The breaking of the governor rods was probably caused by the tail of the hooks dropping behind the square end of the cams when the latter was thrown too far around, due to the slipping of the stop collar.

That being the case, there would evidently be a mark across the tail end of the hook caused by the sharp edge of the steel cam, the hooks being of brass. Inspection revealed such marks on each hook, and on laying the cam in its proper place and bringing the hook up against it, it was found that the edge of the cam fitted into the mark exactly.

Therefore it seems that the cause of the engine running away was the adjustment of this collar. It was either set too low, or if set in the correct position was not sufficiently tightened to prevent slipping. In either case it does not seem to have been tight enough to resist the upward pull of the governor sleeve.

Suppose it is set too low and the engine is suddenly relieved of all its load. The engines will speed up, the governor rising to the collar, the steam valves still opening too wide, the engine increases in speed, placing more stress against this collar. Just before the speed becomes too great for the wheel to withstand, this collar slips, the governor moves up far enough to roll the knockoff cams past the tail of the hooks. The latter, on their return, catch the square end of the cams, shearing them off, breaking the governor rods at the same time and augmenting the upward movement of the governor sleeve, thus pushing the sleeve and collar up to where they were found and the piston of the gag-pot clear of the cylinder.

Suppose this collar is set in the correct position, but not properly secured. It might have been possible for the engine to have speeded up sufficiently to have thrown the governor sleeve against this collar about the time the engineer arrived, and slipped it far enough to allow the hooks to catch the cams as stated. In this condition the engine would probably require only a stroke or two with steam following the length of the cylinder, to reach the bursting point of the flywheel.

It was suggested by a few that the cams could not be thrown clear under the hooks as stated, but on testing it on a duplicate engine of the one wrecked it was found that it could be accomplished.

It seems to many that the wrong adjustment of this collar was the cause of the wreck. Of course, the real starting of it was through the breaking of the driven pulley.

It is well to test the adjustment of this collar from time to time for it may be needed only once in the life of the engine, but it will be fraught with constant danger if allowed to become other than correctly adjusted. Changing the reach-rods of a governor from time to time will necessitate the readjustment of this collar. A knockoff cam should be made longer or tapered at both ends. Either will prevent the hook catching when the cams are rolled too far under.

JOSEPH STEWART.

Hamilton, Ohio.

Priming a Condenser-Circulating Pump

In a certain plant with which the writer is acquainted, much difficulty was experienced with priming the circulating pumps of a condenser. These pumps were arranged to draw water from two sources; one feed was from a head race and the water was supplied to the pumps under a head of 10 ft. At times this supply source could not be depended on, due to the clogging of the trash racks over the intake pipe, with leaves and ice. At times also during repairs to the race, this supply was cut off entirely. When this happened the other connection, drawing water from the river, under a suction lift of about 5 or 6 ft., was used. Great difficulty was experienced in getting the pump to lift the water, because of

the lack of means for priming. It was thought that sufficient water could always be obtained from the race for this purpose, which, however, proved untrue.

A quick means for accomplishing this priming was necessary as the condenser depended upon these pumps and the loss of vacuum attending would cause a serious shutdown. The following plan was suggested to my mind by the proximity of the dry-vacuum pumps which were a part of the condenser equipment. A three-quarter hole was drilled and tapped in the intake pipe of the air pump at its highest point, and in the casing of the centrifugal pump. These two holes were connected by means of a pipe, with a valve inserted in it, near the circulating pump. The air in the suction line could then be exhausted by means of the vacuum pump and the water would rise in the pipe, due to the atmospheric pressure, allowing the pump to readily pick up its water. The valve would then be closed, preventing any water from being drawn over into the air pump.

This plan was not put into effect, to the writer's knowledge, only suggested by him as a way out of a difficulty.

JAMES M. PURCELL.

Richmond, Va.

Lubricating Links of Duplex Pumps

The links as made by the manufacturer were as shown at the left of the illustration. Difficulty was experienced in lubricating these links and pins to prevent them wear-

GREASE CUP TO LUBRICATE PUMP LINKS

ing rapidly. New links and pins were finally obtained, the pins being made as shown at the right. By using grease cups the lubrication is better and the pins last much longer than formerly.

A. R. KUMMERER.

Hazleton, Penn.

Your Son's Vocation

The editorial, "Your Son's Vocation," in the Oct. 28 issue, brings up a subject uppermost in the minds of men who have the welfare of their children at heart.

As a general rule, most boys show more interest in things mechanical than in any others. This is before they are old enough to think seriously about the vocation for which they are best fitted. By the time the boy has gone through common school, and in many cases before that, it is usually possible to determine in which direction his ambition lies and in what line of work he is most likely to succeed. If his bent is mechanical and he is sure that nothing but an engineer's life will suit him, by no means should he be denied an opportunity to make good. But he should be given at least a technical high-school education and if possible more than that. He should not be handicapped by having to start to work with no theoretical training. It is true that there are men holding responsible and well paid positions in the engineering field who, in their youth, did not have anything more than the "three R's," but their rise has been in spite of their lack of early training and not because of it. It is possible to obtain, by home study, the equivalent of a college course in engineering, but it is mighty hard work and every man who tries it will have to admit that the proper place to acquire such an education is in the classroom, and the proper time is before one has to go to work to earn his own bread and butter.

Whether or not it is wise to keep a line of descent in one line of work is a question that the writer believes can be left to nature. If a youth shows an inclination to follow any one line of employment, let him proceed. Nature fitted him for it and it would not be right to deny him the right to profit by his natural ability for his chosen work.

A. T. WALKER.

Washington, D. C.

Maltreatment of Apparatus

As an example of the maltreatment of apparatus by careless employees, I would like to cite an example of a turbine-driven feed pump, which had been returned to the concern where I am employed as testing engineer, for failure to attain rated conditions after two years of perfect service.

The unit was set up preparatory to testing and had been running about 10 min., when it suddenly slowed down. Examination showed that the pump bearings were running hot, so we shut down and dissembled the pump. In the forward bearing of the pump we found that the oil-ring had been substituted for by a piece of twine, which was useless for its purpose.

The adjusting screw in the thrust bearing had been screwed up so far that the impellers were thrown out of line, and the shaft collars had by their excessive pressure against the thrust block, broken off several of the rings in the split thrust bush. Furthermore, we discovered a couple of nuts in the impellers. How they got there I cannot imagine, and their effect upon the capacity of the pump I will not attempt to describe.

Is it any wonder that the outfit failed to come up to its guaranteed conditions? Subsequent remedying of the above defects proved that the outfit was fully capable of attaining its designed conditions.

This is only one case out of many of the attempts on the parts of plant owners to economize in the wrong direction by the use of cheap and unskilled labor, and as usual the result is always the same. The above outfit had been shipped from the Pacific Coast to the East, and this would have been unnecessary if ordinary judgment had been used on the parts of those in charge.

HENRY W. WETJEN.

Newburgh, N. Y.

Painted Valve Stems Indicate Valve Positions

I find it very troublesome to climb up ladders and over brick walls to find out if certain valves are open or closed. I closed the valves and then painted the stems down to the packing gland. Now I can tell whether a certain valve is open or closed by merely glancing at it.

Cylinder oil and melted paraffin make a fine remedy for burns from live steam.

STANLEY RADCLIFFE.

Laurel, Md.

INQUIRIES OF GENERAL INTEREST

Pump Capacity—Will air chambers installed in both the suction to and discharge from a pump increase its capacity?

J. W. D.

Yes; they will reduce pump-piston slippage and thereby increase the capacity of a pump.

Resistance of Mercury Column—What is the resistance in ohms of a round column of mercury 70 in. high, 0.05 in. in diameter?

C. W.

1.3226381 ohms.

Compensator—What is a compensator?

V. A. N.

"Compensator" is the term applied to an auto-transformer for starting an electric motor. A description of one is given in the electrical department of the Dec. 2 issue of "Power," under the subject of "Induction Motors."

Relative Current Consumption—Will a 50-hp. induction motor pulling a 30-hp. load consume more current than a 30-hp. motor carrying the same load?

E. M.

Yes, because an induction motor has a lower power factor when running underloaded.

Safety Valve Sizes—For a given size boiler why should a lever safety valve be required to have a larger area than a spring-loaded valve?

J. W. D.

Pop safety valves of ordinary good construction are prompter by reason of having less friction of moving parts and are made to lift higher and hence may be smaller than lever safety valves.

Refrigeration Loss—What will be the loss in horsepower-hours in a brine tank containing 15,000 gal. of a 20 per cent. solution of brine, for a 1-deg. F. rise in temperature?

A. A. R.

The brine will have a specific gravity of 1.18 at 62 deg. F. The heat required to raise or lower 1 lb. of such a solution 1 deg. would be 0.834 B.t.u. As 1 gal. would weigh

$$8\tfrac{1}{3} \times 1.18 = 9.833 \text{ lb.},$$

then 15,000 gal. would weigh

$$15{,}000 \times 9.833 = 147{,}495 \text{ lb.},$$

requiring

$$147{,}495 \times 0.834 = 123{,}010.83 \text{ B.t.u.}$$

for raising it 1 deg. F. There being 2546 B.t.u. per horsepower per hour then warming or cooling of this quantity of water 1 deg. F. per hour would be at the rate of

$$123{,}010.83 \div 2546 = 48.31 \text{ net hp.}$$

Modified Furnace Design—Would it be practicable to install a heavy cast-steel hollow arch in a Dutch oven and force the water from the heater at about 212 deg. through this arch to the boiler to increase the life of the arches at present so frequently destroyed by the intense heat?

W. C. C.

The advantage of a Dutch-oven furnace arises from the fact that the roof and furnace lining are at high temperature and do not retard complete combustion like the colder heating surface of a boiler. To form the roof of water arches would have the same detrimental effect as to extend the heating surface of the boiler over the fire, i.e., there would be no advantage over an ordinary boiler setting with the boiler set the same distance above the fire. Such a water-arch covering would be not only detrimental to the efficiency of combustion, but also would be in danger of burning out or exploding from the formation of mud or scale deposits.

Clearance—How is the clearance space of an engine found; also the striking clearance?

M. W. C.

The volume of clearance space in each end of an engine cylinder is determined by placing the piston at the end of the stroke and noting how much water is required to fill the clearance spaces from the piston back to the steam valve. If the water is measured by weight instead of volume the equivalent volume can be found by multiplying the weight of water in pounds by 27.77; the quotient will be the number of cubic inches of clearance space. To find the percent. of clearance, first find the displacement volume of the piston by multiplying its area in square inches by its stroke in inches and divide the clearance volume by the displacement volume. To find the striking clearance of the piston, place the engine on dead center; then make a mark on the crosshead and guides, one registering with the other; detach the connecting rod and see how much farther the crosshead can be moved before the piston touches the head of the cylinder.

Freezing Air-Drill Exhaust—What makes the exhaust from an air drill freeze and how can it be prevented?

J. R. T.

The exhaust freezes because when the air is first taken in by the compressor it contains moisture. When the air is compressed its temperature rises both because the heat contained is concentrated into a smaller space and because the work of compression is stored up in the air. When compressed to a temperature above the temperature of the atmosphere, it cools down, losing some of its heat. Consequently, when expanded down again, its temperature falls and any moisture contained in the air freezes and may clog the drill, or the air itself, being cooler than the atmosphere, may freeze the moisture of the atmosphere into which it is exhausted. Freezing up of rock drills can be prevented by taking in dry air to the compressor, or by using a reheater which usually consists of a "sugar loaf" type of stove in which the air is reheated by being passed through a pipe coil surrounding the fire pot of the stove. The reheater should, of course, be placed near the drills.

Peculiar Gage Action—In the morning two "gages" of water are found in the glass. After a few minutes the water has gone up in the glass, although no water is being fed. When the gage cocks are opened they blow dry steam. What is probably the trouble?

H. E.

A full water gage may be shown at any time when the boiler is under a few pounds of steam pressure and the upper gage-glass connection is closed deliberately or accidentally stopped. In this case the upper connection was probably closed, and the pressure had gone down in the boiler during the night so that there was not sufficient acting in the lower end of the glass gage to hold the water in the glass higher than the level at which it was found; there being a partial vacuum in the upper end of the glass gage, the water stood higher than the level of water in the boiler. After getting up a little steam pressure the pressure of steam on the water in the boiler forced the water to the top of the glass gage, although during the whole time the actual level of water in the boiler was lower than shown by the glass gage.

Boiler-Evaporation Problem—A boiler generates steam at 105-lb. gage pressure. The feed-water temperature is 203 deg. F.; the efficiency of the furnace and boiler is 70 per cent., and the coal contains 14,000 B.t.u. per lb. How many pounds of water will the boiler evaporate per pound of coal?

J. P. L.

Steam at 105-lb. gage pressure would be at

$$105 + 14.7 = 119.7 \text{ lb. absolute pressure,}$$

containing practically the same heat as at 120 lb. absolute. The total heat above 32 deg. F., as obtained from Marks and Davis' steam tables, is 1189.6 B.t.u. per lb. (weight). The initial feed-water temperature being 203 deg. F., each pound already contains

$$203 - 32 = 171 \text{ B.t.u.}$$

Each pound of water made into steam, therefore, requires

$$1189.6 - 171 = 1018.6 \text{ B.t.u.}$$

A pound of coal containing 14,000 B.t.u. with a 70 per cent. efficiency of furnace and boiler would impart

$$0.70 \times 14{,}000 = 9800 \text{ B.t.u.}$$

to the water. Therefore, each pound of coal could evaporate

$$\frac{9800}{1018.6} = 9.62 \text{ lb. of water}$$

into dry, saturated steam at 105 lb. gage pressure.

ENGINEERS' STUDY COURSE

Trigonometry—IV

LAST LESSON'S ANSWERS

11. The tangent and cotangent of the same angle being reciprocals (last rule in the last lesson) if $tan\ A = 3$, $cot\ A = \frac{1}{3}$.

12. Given $tan\ A = \frac{4}{5}$. The tangent and cotangent being reciprocals $cot\ A = \frac{5}{4}$. Substituting in equation 7 (last lesson),

$$sec^2\ A = 1 + (\tfrac{4}{5})^2 = 1 + \tfrac{16}{25} = \tfrac{41}{25}$$

and

$$sec\ A = \sqrt{\tfrac{41}{25}} = \frac{\sqrt{41}}{5}$$

The secant and cosine being reciprocals

$$cos\ A = \frac{5}{\sqrt{41}}$$

Substituting in equation 1

$$sin^2\ A + \left(\frac{5}{\sqrt{41}}\right)^2 = 1$$

$$sin^2\ A = 1 - \left(\frac{5}{\sqrt{41}}\right)^2 = 1 - \tfrac{25}{41} = \tfrac{16}{41}$$

and

$$sin\ A = \sqrt{\tfrac{16}{41}} = \frac{4}{\sqrt{41}}$$

The cosecant and sine being reciprocals

$$csc\ A = \frac{\sqrt{41}}{4}$$

Substituting in equation 9

$$vers\ A = 1 - \frac{5}{\sqrt{41}}$$

Substituting in equation 10

$$covers\ A = 1 - \frac{4}{\sqrt{41}}$$

13. Draw an angle of 30 deg. as BAC, Fig. 5, with AB equal to 1 (any unit), and AC a horizontal line. Below this horizontal line draw another angle of 30 deg., CAD. These angles being equal their cosines are equal and in fact coincide as represented by the line AE. Therefore, the sines BE and ED of the two 30-deg. angles will be continuations of one another, and equal because they are the sines of equal angles. Being equal, the angles of which they are cosines, ABE and ADE, are equal, as is also known from the fact that they are both complements of 30-deg. angles and hence 60 deg. (90 — 30 = 60). There is now constructed an *equiangular triangle* (one in which all of the angles are equal) $ABDA$. Now, if a line be drawn from B to the opposite side AD and at right angles to it, as BF (this is called dropping a perpendicular to AD) it will divide the triangle $ABDA$ into two right triangles $ABFA$ and $BDFB$, and angles BAF and BDF being angles of 60 deg., angles ABF and DBF be angles of 30 deg., showing that the perpendicular *bisected* (divided in two equal parts) the angle ABD, already shown to be one of 60 deg. These angles being equal, their sines, AF and FD are equal, hence bisect the line AD, which by construction was equal to 1. Hence it is proved that $sin\ 30\ deg. = \frac{1}{2}$. Incidentally, BE and ED, each being a sine of 30 deg. and therefore equal to $\frac{1}{2}$, it proves that the chord of an angle (or arc) of 60 deg. is equal to 1, for such is BD. Another truth established is that the sides of an equiangular triangle are equal, and therefore such a triangle is also known as an *equilateral triangle.*

14. The sine of 30 deg. being $\frac{1}{2}$, by equation 1

$$cos\ 30° = \sqrt{1 - (\tfrac{1}{2})^2} = \sqrt{1 - \tfrac{1}{4}} = \sqrt{\tfrac{3}{4}} = \frac{\sqrt{3}}{2}$$

and, being the reciprocal of the cosine,

$$sec\ 30° = \frac{2}{\sqrt{3}}$$

By equation 2

$$tan\ 30° = \frac{\frac{1}{2}}{\frac{\sqrt{3}}{2}} = \tfrac{1}{2} \times \frac{2}{\sqrt{3}} = \frac{1}{\sqrt{3}}$$

and, being the reciprocal of the tangent,

$$cot\ 30° = \sqrt{3}$$

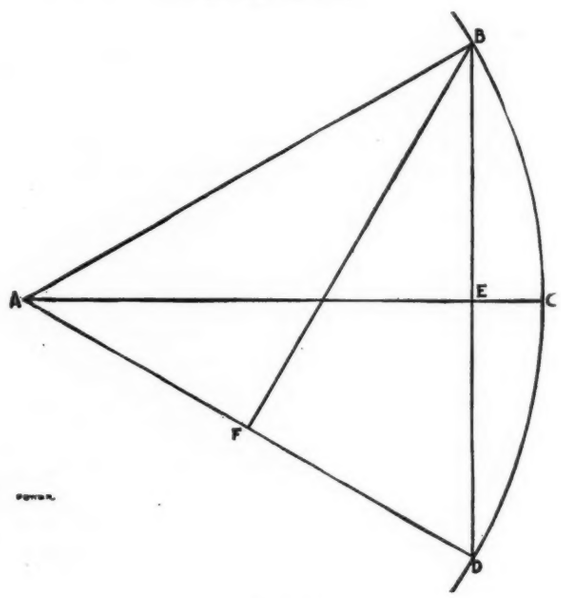


FIG. 5

Being the reciprocal of the sine

$$csc\ 30° = 2$$

By equation 9

$$vers\ 30° = 1 - \frac{\sqrt{3}}{2}$$

By equation 10

$$covers\ 30° = 1 - \tfrac{1}{2} = \tfrac{1}{2}$$

15. The sine of an angle being the cosine of its complement and 45 deg. being the complement of 45 deg., the

sine and cosine of 45 deg. are equal. In equation 1, substituting cos^2 for sin^2.

$$2\ sin^2\ 45° = 1$$

or

$$sin^2\ 45° = \tfrac{1}{2}$$

or

$$sin\ 45° = \sqrt{\tfrac{1}{2}} = \frac{1}{\sqrt{2}} = \text{also } cos\ 45°$$

Being the reciprocal of the cosine,

$$sec\ 45° = \sqrt{2}$$

Being the reciprocal of the sine,

$$csc\ 45° = \sqrt{2}$$

By equation 2

$$tan\ 45° = \frac{\frac{1}{\sqrt{2}}}{\frac{1}{\sqrt{2}}} = 1$$

Being the reciprocal of the tangent,

$$cot\ 45° = 1$$

By equation 9

$$vers\ 45° = 1 - \frac{1}{\sqrt{2}}$$

By equation 10

$$covers\ 45° = 1 - \frac{1}{\sqrt{2}}$$

Functions of the Sum and Difference of Angles

Designating any two angles by A and B, the functions of their sums and differences may be deduced. Taking, as the first proposition to prove that *the sine of the sum of two angles is equal to the sine of the first times the cosine of the second, plus the cosine of the first times the sine of the second.*

Referring to Fig. 6, let angles CAB and BAD represent any two angles A and B, respectively laid off with a measuring circle CBD of unit radius. BE and DF represent then the sines of the two angles separately and DI the sine of the sum of the two angles. By the proportionality of the sides of similar triangles (Lesson I, Nov. 25, 1913)

$$\frac{FG}{BE} = \frac{AF}{AB}$$

$$FG = \frac{BE \times AF}{AB} = \frac{sin\ A\ cos\ B}{1}$$

Also triangle $DFHD$ is similar to triangle $ABEA$ (because each side of the one is perpendicular to the corresponding side of the other) and

$$\frac{DH}{AE} = \frac{DF}{AB}$$

$$DH = \frac{AE \times DF}{AB} = \frac{cos\ A\ sin\ B}{1}$$

Since

$$HI = FG$$

$$DI = FG + DH$$

or

$$sin\ (A + B) = sin\ A\ cos\ B + cos\ A\ sin\ B \qquad (11)$$

To show that *the sine of the difference of two angles is equal to the sine of the first times the cosine of the second, minus the cosine of the first times the sine of the second.*

Let the angle A now be represented by the angle CAD, Fig. 6, and the angle B by CAB. Again, by similar triangles.

$$\frac{DH}{AE} = \frac{DF}{AB}$$

$$DH = \frac{AE \times DF}{AB} = \frac{cos\ B\ sin\ (A - B)}{1}$$

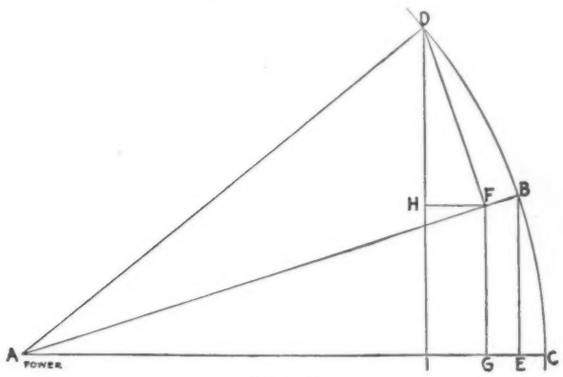


Fig. 6

and

$$\frac{FG}{BE} = \frac{AG}{AE}$$

$$FG = \frac{BE \times AG}{AE} = \frac{sin\ B \times AG}{cos\ B}$$

but

$$AG = AI + IG$$

or, since

$$IG = HF$$

$$AG = AI + HF = cos\ A + HF$$

Again, by similar triangles

$$\frac{HF}{BE} = \frac{DF}{AB}$$

$$HF = \frac{BE \times DF}{AB} = \frac{sin\ B\ sin\ (A - B)}{1}$$

Substituting in the equation for AG

$$AG = cos\ A + sin\ B\ sin\ (A - B)$$

and substituting this value for AG in the equation for FG

$$FG = \frac{sin\ B\ [cos\ A + sin\ B\ sin\ (A - B)]}{cos\ B}$$

$$= \frac{sin\ B\ cos\ A + sin^2\ B\ sin\ (A - B)}{cos\ B}$$

Now

$$DH = DI - HI$$

or, since

$$HI = FG$$

$$DH = DI - FG = sin\ A - FG$$

Substituting the values already found for DH and FG

$$cos\ B\ sin\ (A - B) = sin\ A - \frac{sin\ B\ cos\ A + sin^2\ B\ sin\ (A - B)}{cos\ B}$$

Multiplying both sides of the equation by $cos\ B$

$$cos^2\ B\ sin\ (A - B) = sin\ A\ cos\ B - sin\ B\ cos\ A - sin^2\ B\ sin\ (A - B)$$

Transferring the last term to the other side of the equation to collect like terms

$$cos^2\ B\ sin\ (A - B) + sin^2\ B\ sin\ (A - B) = sin\ A\ cos\ B - sin\ B\ cos\ A$$

and simplifying

$$[cos^2\ B + sin^2\ B]\ sin\ (A - B) = sin\ A\ cos\ B - cos\ A\ sin\ B$$

since

$$\cos^2 B + \sin^2 B = 1$$

$$\sin (A - B) = \sin A \cos B - \cos A \sin B \qquad (12)$$

STUDY QUESTIONS

16. Given $\sin 30° = \frac{1}{2}$, and $\sin 45° = \sqrt{\frac{1}{2}}$, find $\sin 75°$.

17. Given the same, find $\sin 15°$.

18. Deduce an expression for the sine of the sum of two angles plus the sine of their difference.

19. Show that *the cosine of the sum of two angles is equal to the product of their cosines minus the product of their sines.*

20. Show that *the cosine of the difference of two angles is equal to the product of their cosines plus the product of their sines.*

Blonck Boiler-Efficiency Recording Meter

The accompanying illustrations show the newly developed recording type of Blonck boiler-efficiency meter, manufactured by W. A. Blonck & Co., Fisher Bldg., Chicago, Ill. As in the indicating type, the recorder shows the draft resistance of the fuel bed and the drop in draft between furnace and damper. The two records are made on the same chart and for clearness one is registered in red, and the other in blue ink.

The recorder is to be used in conjunction with the indicating meter, the former located where the chief engineer or superintendent may have ready access to it and the latter on the boiler front for the guidance of the fireman.

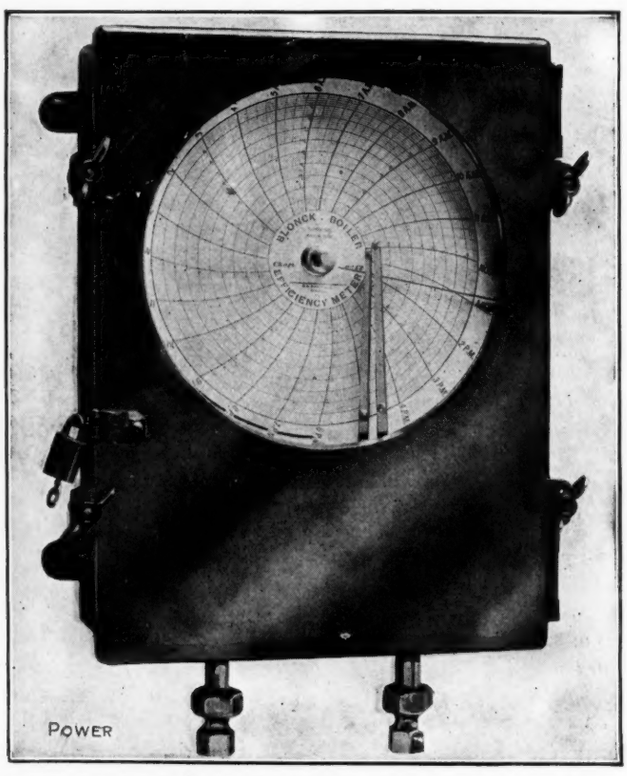


FIG. 1. BLONCK BOILER-EFFICIENCY RECORDING METER

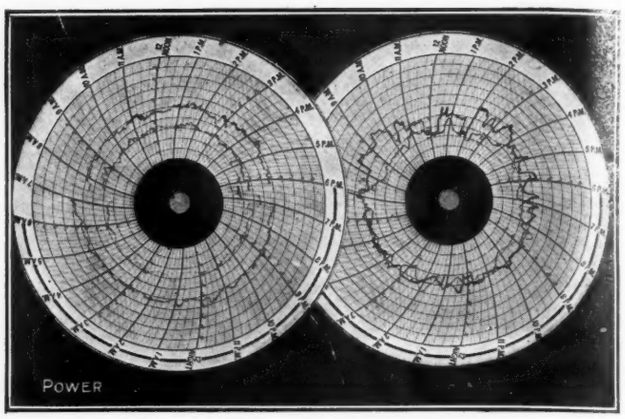


FIG. 2. SPECIMEN CHARTS SHOWING POOR AND GOOD OPERATION

The charts in Fig. 2 show conditions before and after the Blonck indicating meter was applied and its use explained to the fireman. The boiler affected is a 500-hp. horizontal water-tube unit fitted with a traveling chain grate. The total available draft is somewhat more than 0.8 in., water gage, and investigation showed that for highest efficiency under normal conditions of load, the draft through the fuel bed should be 0.3 in. and that through the boiler, 0.5 in.

On the upper chart, taken before the fireman was instructed, the draft distribution is irregular, extreme variations occurring within short periods. The draft through the fuel bed varied from the maximum of 0.5 in. near 2 a.m. to the minimum of 0.18 in. at 2 p.m. With the damper position unchanged a decrease in the draft through the fuel bed results in admission of excess air and resultant waste. Excess air means a greater volume of gases flowing through the boiler per unit of time and, hence, an increase in the draft between furnace and damper. These facts account for the behavior of the two record lines of the charts at the points where they are converging or diverging.

During the periods (exceedingly brief on the upper chart) when the lines run practically parallel, as at 9 a.m., the conditions remain uniform. When the record shows a decrease in both the draft through the fuel bed and that through boiler, the indications are a decrease in the rate of combustion (hence, decrease in steam output also) and no change in efficiency. When increase in both furnace and boiler draft is shown, the indications are increase in rate of steaming and no change in efficiency.

Other things remaining the same, the rate of steaming or boiler capacity developed and the efficiency of the boiler depends solely upon the available draft and the distribution of that draft. This being true, it is possible to study a given set of boiler conditions so thoroughly that, with the Blonck meter, practically all changes that occur to affect the two factors of capacity and efficiency, can be instantly detected. Indeed, so absolute is the relation between draft and capacity and efficiency, that even fallen baffles and soot or slag accumulations on the tubes may be discovered through their effect on draft distribution.

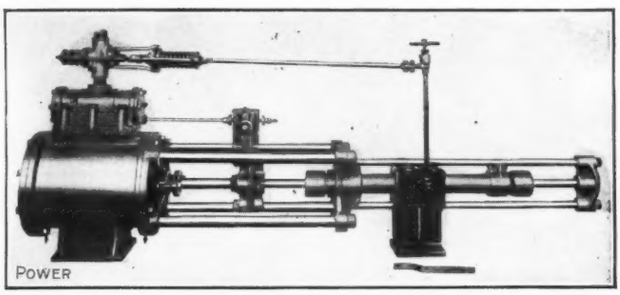
The total horsepower of turbines now installed or on order with the Parsons Marine Steam Turbine Co. exceeds 10,000,000, of which 2,100,000 hp. has been ordered within the past year.

Steam-Driven Hydraulic Pump

The illustration shows one of a new line of steam-driven hydraulic pumps built by the Hydraulic Press Manufacturing Co., Mount Gilead, Ohio. Based on the steam-end dimension the line covers 12 sizes, and on the water-end dimension 71 sizes. This pump is of the single-cylinder, double-acting type.

The stroke is longer than has been provided by previous designs. The number of strokes is proportionately less. This reduces the slippage at the water valves as well as the wear on all moving parts. Another advantage is that a given steam piston can be used with various sizes of water plungers to give capacities desired, or the steam pressure may be reduced to obtain a given water pressure.

The design of valves and gears prohibits the short stroking of the pump. The steam valve-gear permits adjustment to be made while the pump is in motion. The cushioning of moving parts is positive and does not require adjustment. Steel forgings are used for all water



STEAM-DRIVEN HYDRAULIC PUMP

ends for pressures above 2000 lb. The water valves are large in area. All the seats are removable and all parts are accessible.

Mounted on the steam chest is shown the pressure and speed governor which regulates the speed and pressure of the steam-driven hydraulic pump. It can be used as a simple automatic control for any make of hydraulic steam pumps. It is provided with an adjustment which can be set to govern any speed and pressure desired. It cuts off the steam supply to the pump when the predetermined maximum pressure is reached, and regulates the speed of the pump to any number of strokes for which it may be adjusted, thus preventing the pump from racing, should the pressure be released suddenly.

⁂

A 250-Mile Pipe Line is being built for H. M. Byllesby & Co., of Chicago, from the West Virginia Gas Fields to Louisville, Ky. Some 76 miles of difficult construction through the mountains has already been completed.

⁂

Coal Bulletin—The Bureau of Mines bulletin No. 22 treats of an analysis of 5000 samples of coal that have been collected by experienced government agents from 1500 mines in the United States. The bulletin is in two sections, one giving the methods of procedure followed in taking samples and in testing them and the other showing the location of the coal mines where the samples were obtained and data on the physical conditions existing at the different mines, their capacity and their methods of preparing coal for the market. Such a book should be valuable to power-station managers who could, by referring to it, make analysis of coal by the best approved method and find out much valuable information on the condition of the mines from which his coal is taken and obtain a rough figure of the heating value of the coal by knowing the location of the mine. Copies of the bulletin may be obtained by addressing Bureau of Mines, Washington, D. C.

OVER THE SPILLWAY

JUST JESTS, JABS, JOSHES AND JUMBLES

"Safety first!" is bully, but it's a big financial undertaking for the railroads alone. For two moves in this direction it will require nearly a billion of dollars—$700,000,000 to replace wooden cars with steel; $300,000,000 for suitable signal services. This does not include better track, bridges, stations, grading, etc.

⁂

"Are factory whistles necessary?" is being discussed by a contemporary. Factory whistles have very little to blow about these days what with the "Big Boob" and the "Insomnia" clocks, and other contraptions that rob us of our early-morning rest. The time-clock is the merry little chirper for starting-time with the majority of us, and most any simp knows when to stop.

⁂

The first elevator installed in a New York office building was in the old Equitable, in 1870. On this same site today there is being erected a building that will house more elevators than any other structure in the world. Going up? You bet!

⁂

The Emproar Willyum finds time during his many activities to inveigh against the smooth upper lip. Willyum gets in dutch with us when he says "a real man wears a mustache." While we let the cook strain our soup, we are perfecting a patent muffler for those diners who do their own straining. And this silencer will be all to the consommé!

⁂

Chimnies are running a close second with the "largest" turbine, steamship and engine. We will soon have a 400-ft. steel stack out in Jerome, Ariz., the steel for which is being "fabricated," says a contemporary. And still they say engineers are poor writers!

⁂

"Bangor Whiskey Explodes."—Headline.

The Bangor brand must be some lively stuff. Around here our kind sort of leans up against the bottle, has no energy, no kick—just completely disheartened and spiritless. Bangor might be a good place to spend our next vacation if—

⁂

Another one of those lively "get-acquainted" towns is Racine, Wis., evidence of which is shown in the pictorial supplement of the "Journal-News." Pretty nigh all the home-folks got in the picture, including George H. Wallace, "engineer and writer," who sits plumb up against the clergy, the law, medicine, a couple of cheery-looking undertakers, and a dentist who seems to have had a strong pull with Geordie.

⁂

"Set domestic science to music."—Daily Paper.

Not for ours! Once, in the long ago, our blushing bride meant well when she started to sing as she started to cook. And she never afterward learned to love "Where Is My Wandering Boy Tonight?" You have to be good at both to win out.

⁂

"Agricultural production, marketing and coöperative effort are matters of major importance, and any help you can give the farmer will benefit your readers," the New York City Club tells us. We wish we could do just this little thing for Si, Hi and Ezry, but— "Power" is an operating engineers' paper. If we ever do take on an extra department, our first sympathies are for a "Hints to Mothers" or "Balm for Wounded Hearts" column.

⁂

This is a pretty kettle of fish! Harry Schmelt went swimming among the household effects of one Jacob Herring, of New York City. Schrimp was the cop who threw the hook into Schmelt and landed him in the "aquarium." Evidently Schmelt mistook Herring for an oyster as he opened up on a pearl necklace belonging to Mrs. Herring.

⁂

Hooray for the "Auburn (N. Y.) Citizen." Some civic pride and boosting of "the home of the Diesel engine"—that's Auburn! This live-wire paper had a corking good story on the new McIntosh & Seymour Corporation, and yards of it. Go it, "Auburn Citizen," we like your enterprise.

Mechanical Engineers' Convention

In point of attendance the thirty-fourth annual meeting of the American Society of Mechanical Engineers, held in New York City, Dec. 2 to 5 inclusive, was the largest in the history of the society. Almost thirteen hundred registered, there being 794 members and 504 guests present. Not only did the large attendance speak well for the efforts of the Meeting Committee in providing an attractive program, but the interest manifested in the papers presented, as shown by the active participation in the discussion and the numbers which took part in the various excursions, indicated that the technical and social entertainment provided was highly appreciated.

OPENING SESSION

The meeting was formally opened Tuesday evening in the auditorium of the Engineering Societies building with the presentation of the address of the retiring president, Dr. W. F. M. Goss. His subject was "Technical Education a Factor in the Development of Professional Ideals." As an educator of prominence himself the speaker was well qualified to draw conclusions from the history of technical education

JAMES HARTNESS, NEWLY ELECTED PRESIDENT OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

in the last forty years of its development as to its trend at the present and the lines along which it will probably progress. He regards the pioneer days as substantially over, that the industries and professions generally now have confidence in the technical graduate and that more and more will be expected of him, requiring that henceforth those who would reach the highest positions should follow post-graduate work and give considerable attention to research.

Following the address the report of the tellers of election was given and the following officers for the ensuing year were declared elected: President, James Hartness, Springfield, Vt.; vice-presidents, Henry L. Gantt, New York; E. E. Keller, Detroit, Mich.; H. G. Reist, Schenectady, N. Y.; managers, A. M. Greene, Jr., Troy, N. Y., John Hunter, St. Louis, Mo.; Elliott H. Whitlock, Cleveland Ohio; treasurer, William H. Wiley, New York.

There followed the reception to the retiring and newly elected presidents in the society's rooms with an informal dance and collation.

THE NEW PRESIDENT

James Hartness was born in Schenectady, N. Y., in 1861. After completing his education, he worked as foreman in several different manufacturing plants in Connecticut, and, in 1888, became connected with the Jones & Lamson Machine Co., Springfield, Vt. He served successively as superintendent, manager and president, which position he now holds. Mr. Hartness is an inventor and author of note in the engineering world, having brought out numerous labor-saving machines, among them being the Flat Turret lathe and the Lo-Swing lathe.

In 1910 he invented a turret equatorial telescope, which permits the astronomer to make observations without being exposed to the cold in extremely cold weather. This accomplishment has been generally considered a marked advance in the science of optics, and that it will have an important bearing on the work of astronomers.

Mr. Hartness is a member of numerous engineering and scientific societies, both American and foreign, and is the author of "Machine Building for Profit" and "The Human Factor in Works Management."

WEDNESDAY SESSIONS

In the auditorium Wednesday morning was held the annual business meeting at which were presented the reports of the Council and standing committees. Among the latter was the report of the subcommittee on fire protection which recommended a national standard for hose couplings to do away with the present difficulty when adjacent towns attempt to help one another during serious conflagrations and are hampered by the variance in threaded connections now in use.

The Committee on an International Standard for Pipe Threads has sent to the Paris representative, L. B. Benet, instructions for presentation to the International Commission on Pipe Threads. At the request of a number of members and manufacturers, a committee was appointed and presented a report on the fixing of manufacturing limits in flanges and fittings threaded according to the Briggs standard. A report is before the Council recommending the appointment of a committee to act as a clearing house for all matters of standardization.

A spirited discussion resulted over the report of the Committee on Standardization of Flanges. This schedule, known as the "1914 Standard," which was reported in "Power," Oct. 14, 1913, represents a compromise between the 1912 standard, adopted jointly by the American Society of Mechanical Engineers and the Master Steam and Hot Water Fitters Association, and the 1912 Manufacturers' standard. Representatives of the Master Steam and Hot Water Fitters Association objected to the new schedule on the ground that the 1912 standard had already been adopted by various departments of the Government as well as several manufacturers who had already changed their patterns to conform to it. The association contended that it had not been given ample opportunity to express its views when the new schedule was being devised. It insisted that if a compromise schedule were to be provided the interchangeability feature of the 1912 standard should be retained and that it should be known as the "1912 Standard Revised to Jan. 1, 1914," instead of the "1914 Standard." Moreover it was urged that the larger size flanges should be adopted only after having been approved by the American Water Works Association and the New England Water Works Association.

The proposed new standard was defended by H. G. Stott and W. M. McFarland, both members of the A. S. M. E. committee, who challenged the opposing side to point out any engineering defects in the new schedule, and explained that the interests of everyone concerned would be best served through a compromise, thus doing away with the inconvenience of two standards. A motion was carried, however, to postpone definite action on the new standard until the next meeting of the society, meanwhile affording an opportunity for all factions to get together.

The first professional paper was "Notes on the Further Operation of Large Boilers of the Detroit Edison Co.," by J. W. Parker. Because of the importance of the subject, this paper will be abstracted rather fully in the next issue. Owing to the time consumed by the discussion upon the standardization of flanges, it was found necessary to hold over the rest of the papers scheduled for Wednesday morning until the following day.

In the afternoon three simultaneous sessions were held, one on railroad work, one on cement and one on textiles. The papers presented at the first were "Steel Underframe Box

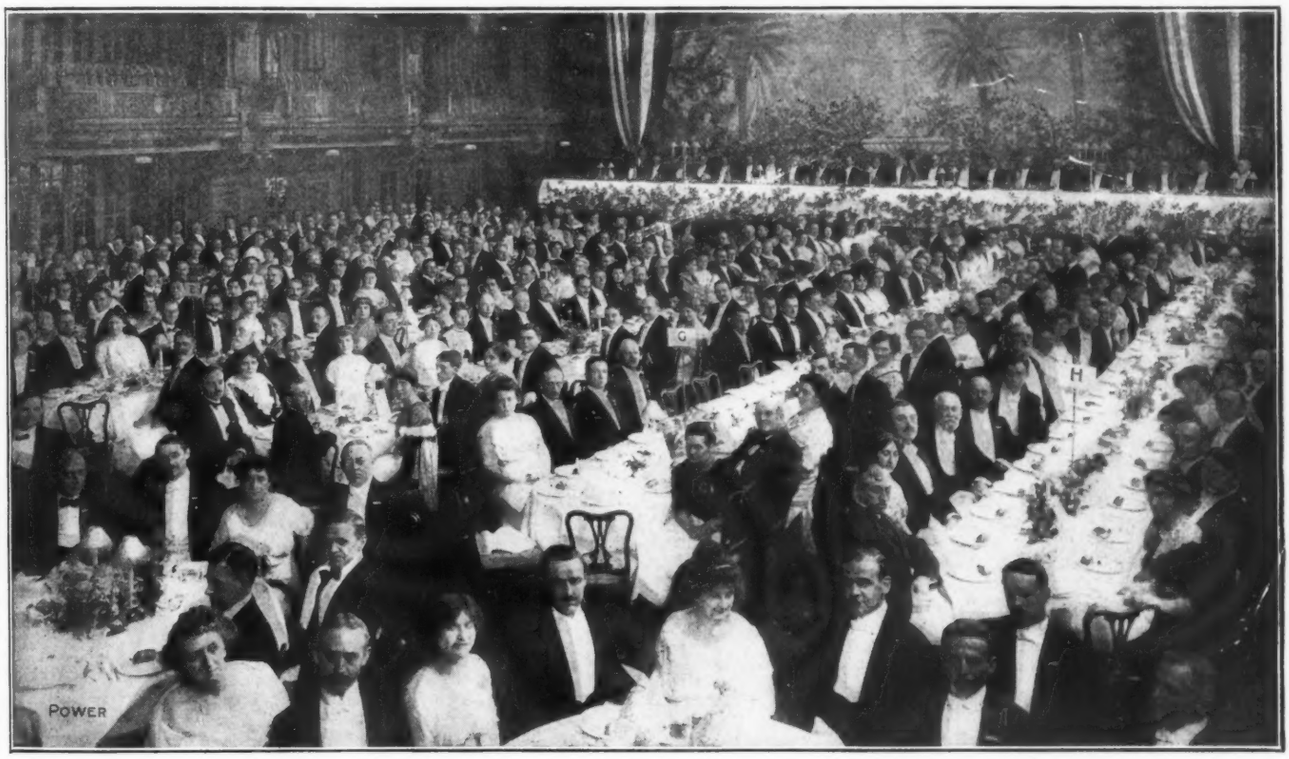
Cars," by George W. Rink, and "Steel Upper Frame Box Cars," by R. W. Burnett. No set papers were provided for the cement session, but opportunity was afforded for those interested in cement manufacture to gather for an informal discussion on various subjects.

The papers contributed by the subcommittee on Textiles included "Cotton Conveying Systems; their Safeguards Against Fire," by H. A. Burnham; "Specifications for Factory Timbers," by F. J. Hoxie, and "Textile Cost Accounting," by C. B. Annett and C. F. Cunningham.

For the ladies there was a reception, musicale and tea in the rooms of the society from 3:00 to 6:00 p.m. to which the members and guests were invited.

Wednesday evening was to have been the occasion of the presentation of the Grashof medal to George Westinghouse, past president and honorary member of the society, the award of which by the Verein Deutscher Ingenieure was made at the joint meeting of the two societies in Germany last summer, as mentioned already in these columns. Unfortunately illness prevented Mr. Westinghouse from being present.

There was no disappointment, however, in any sense of the word in the other feature of the evening's program, an address, illustrated by lantern views on "Leonardo da Vinci—Engineer and Artist," by John W. Lieb, Jr., past vice-president of the society. Renowned as was this great Italian for his achievements in the field of art, few appreciate that he is equally well entitled to a prominent place in the history of engineering and invention. It was a treat indeed and a revelation to many to hear of the extent of the contributions of Leonardo da Vinci to the earlier scientific knowledge.



GERMAN DINNER OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, AT HOTEL ASTOR, NEW YORK CITY, DEC. 4, 1913

THURSDAY SESSIONS

The deferred papers from the Wednesday morning session were given first attention at the general session Thursday morning in the auditorium, while simultaneously sessions on machine-shop practice and gas power were held in other parts of the building.

At the general session the papers were "Task Setting for Firemen and Maintaining High Efficiency in Boiler Plants," by Walter N. Polakov, an abstract of which will be presented later; "The Properties of Steam," by R. C. H. Heck, presented by title only, report of the Sub-Committee on Hoisting and Conveying; "Dynamic Braking for Coal and Ore Handling Machinery," by Clark T. Henderson; "Efficiency of Rope Driving as a Means of Power Transmission," by E. H. Ahara; "Comparative Tests of Three Types of Lineshaft Bearings," by Carl C. Thomas, E. R. Maurer and L. E. Kelso; "Pitot Tubes for Gas Measurement," by W. C. Rowse; "Tests of Vacuum Cleaning Systems," by J. R. McColl; "Tests Upon the Transmission of Heat in Vacuum Evaporators," by E. W. Kerr, and "The Art of Enameling, or the Coating of Steel and Iron with Glass," by Raymond F. Nailler.

The papers contributed by the Sub-Commiteee on Machine-Shop Practice at one of the other two sessions were "Gears for Machine-Tool Drives," by John Parker; "Cast Iron for Machine-Tool Parts," by Henry M. Wood; "A Record of Pressed Fits," by C. F. MacGill, and "Standardizing Machinery," by Fred H. Colvin.

One of the papers presented by the Gas Power Section, "A New Process of Cleaning Producer Gas," by H. F. Smith, was printed quite fully in the Gas Power Department in the last issue. The other, "Present Status of the Large Gas Engine in Europe," by Prof. P. Langer, is to appear later.

Thursday afternoon was left free for excursions and the ladies received in the rooms of the society.

The principal social feature of the meeting was the German dinner and the dance which followed it in the Hotel Astor. As nearly as possible the dinner duplicated the characteristics of the large dinners in Germany last summer when a delegation of some 300 members and guests of the society attended the joint meeting with the Verein Deutscher Ingenieure as reported in "Power," Aug. 5, 1913. Nearly five hundred sat down at dinner and another hundred came later for the illustrated lecture descriptive of the chief features of the German trip by Past-President Worcester R. Warner and the dance which followed. An extensive collection of lantern slides had been made from selections of the numerous snap-shots taken by those on the trip and these and the lecture brought back many pleasant recollections to those who were so fortunate as to have the privilege of being members of the party, while it gave the rest who did not attend somewhat of an idea of the lavish entertainment provided by the German hosts. Numerous speeches and toasts were offered during the dinner between courses and telegrams were read from those who had had a conspicuous part in the entertainment of the society, Dr. Oskar Von Müller, president of the Verein Deutscher Ingenieure, Dr. Conrad Matchoss, who came over in advance of the meeting to invite the American Society to attend and others. The speakers at the dinner were the retiring president, Dr. Goss, who introduced the toastmaster, Prof. L. P. Breckenridge, President-Elect Hartness, who in the absence of the president at the meeting was the official head of the party that went to Germany, Col. E. D. Meier, Prof. A. M. Greene, Jr., Sir Croyden Marks, a guest representing the Institution of Mechanical

Engineers of Great Britain, A. E. Clifford, who had some apt original verses cast in the Kipling and Longfellow molds, and Secretary Calvin W. Rice, whose toast was "The Ladies."

FRIDAY SESSIONS

Friday morning the last professional session was held in the auditorium with a group of papers contributed by the Sub-Committee on Fire Protection. These were "The Fire Hazard in Turbo-Generators," by G. S. Lawler, an abstract of which will be given in a later issue; Extinguishing of Fires in Oils and Volatile Liquids," by Ed. A. Barrier; "Control of Automatic Sprinkler Valves," by Fred J. Miller; "The Need of More Care in the Design and Construction of Elevated Tanks," by W. O. Teague, and "Fire Pumps," by Ezra E. Clark.

At the conclusion of this session the usual vote of thanks to the various committees, individuals and companies, who had contributed to the program of papers and excursions was passed, acting upon a resolution offered by George I. Rockwood.

EXCURSIONS

Friday afternoon was left open for participating in excursions, and others were made throughout the meeting. Among the more important of these were those to the Catskill Aqueduct tunnel construction plants, the Waterside station of the New York Edison Co., the power plant of the Interborough Rapid Transit Co., the Woolworth building and power plant, the "Kaiserin Auguste Victoria," of the Hamburg-American Line, the Pennsylvania R.R. terminal, the Grand Central terminal, the Brooklyn Navy Yard, the National Lead Co., the Tidewater Paper Co. and the E. W. Bliss Co., in Brooklyn, and the Davis-Bouronville company's factory for the manufacture and demonstration of oxy-acetylene welding and cutting equipment, at Jersey City, N. J.

BOTH SIDES OF THE GRASHOF MEDAL AWARDED TO GEORGE WESTINGHOUSE

A number of college reunions were arranged for Friday evening, which was a new feature for an annual meeting. The alumni of Stevens Institute of Technology had a theater party, supper and dance, those of Worcester Polytechnic Institute their annual dinner, and reunion dinners were held by the engineering alumni of the Polytechnic Institute of Brooklyn, Yale University, Cornell University, Kentucky State University and Brown University.

❋

Believes in Safety First

One hundred and fifteen factory foremen of the Goodyear Tire & Rubber Co., Akron, Ohio, have been organized into a compact and aggressive "safety first" battalion. This organization was perfected at a banquet presided over by President F. A. Seiberling and addressed by him and other Goodyear officials, as well as outside experts of note. President Seiberling said: "During the past year, 8000 men have worked for Goodyear, and the coming year this number will be increased to 10,000. It is inevitable among such a multitude that accidents will happen, therefore our foremen need to realize the necessity of safeguards and constant vigilance. This company holds the safeguarding of the lives and well-being of its employees as a high moral obligation."

Moving pictures showing safety devices and the danger of their absence, illustrated various talks. A squad was organized to patrol the 41-acre factory constantly, looking for dangerous operations, instructing workmen, and suggesting safety devices.

Installed but a short time, this "safety first" organization has already caused a noticeable reduction in the number of minor accidents reported among the thousands of the Goodyear Co.'s workmen.

Purifying Apparatus Suit Decided

A final decision from the ultimate court has just been rendered at Cincinnati sustaining the patent of J. C. W. Greth for water-purifying apparatus.

The suit was originally filed before Judge Evans, at Louisville, Ky., in July, 1910, by Wm. B. Scaife & Sons Co., of Pittsburgh, Penn., against the Falls City Woolen Mills, Louisville, Ky., who had installed a continuous water-softening system alleged to be manufactured and furnished by the Fetta Water Softener Co., Richmond, Ind. The Louisville court denied the injunction and appeal was taken to the court of appeals at Cincinnati, which has now reversed Judge Evans, upholding the validity of the patent, and ordered the usual decree for injunction and accounting and recovery of damages.

❋

Marine Engineers' Annual Event

On the evening of Dec. 3, at the Lexington Opera House, Marine Engineers' Beneficial Association No. 33 held its annual entertainment, ball and reception. The arrangement committee included W. J. Du Bois, James O'Keefe, Thomas J. Quigley, J. M. Sterritt, L. F. Oliver, James Moran, Richard Aiken and T. L. Delahunty. Frank Martin was the floor director and Frantzen's orchestra provided the music.

The hit of the entertainment was the minstrel show of the "M. E. B. A. Bunch." John Lloyd Wilson was the interlocutor, and the end men were Monroe Silver, Billy Murray, Ed Meeker and Joe McKenna. Others in the "Bunch" who contributed to the evening's enjoyment were M. J. O'Connell, Jack Armour and F. J. Corbett. Part II of the program included Madeleine Livingston, Whalen, West and Whalen, Matt and Jessie Shaefer, George Andrews, and Clark and Watson.

❋

Change in Chicago Light Rates

In extending on Nov. 26, the franchise of the Commonwealth Edison Co., the city council of Chicago voted to accept the change in electric-lighting rates offered by that corporation. The old rates were 10c. per kw.-hr, for current used up to that quantity which would be consumed by 30 hr. use of the maximum number of lights used and 5c. per kw.-hr. for all consumption in excess of this. The new rates provide for a tertiary charge of 4c. per kw.-hr. for all current in excess of the consumption which would be due to 60 hr. use of the maximum number of lights used. This rate became effective on Dec. 1 and is to be reduced to 3c. on Mar. 1, 1914. The old primary charge of 10c. per kw.-hr. for the first 30 hr. remains while the secondary charge of 5c. is made for the second 30 hr.

It is estimated that the change will not affect some 40,000 small consumers, of the 150,000 customers served, as their service requirements are such that the tertiary rate never becomes effective.

A small faction in the council stood out for a reduction of 1c. in the primary rate and ½c. in the secondary, so that the benefit might be equably distributed among all consumers, both large and small. This faction also urged a franchise period of three years instead of the five granted.

❋

Appropriations to the Bureau of Mines for Coal and Gas Testing

The estimates of appropriations for the United States Bureau of Mines, for the fiscal year ending June 30, 1915, as approved by Secretary Lane of the Interior Department, have just been forwarded to Congress. They total $752,000, and out of this $10,000 is for the equipment of the testing plant at Pittsburgh, $135,000 for testing fuels, and $30,000 for inquiries and investigations of petroleum and natural gas.

The $10,000 asked for the equipment of the testing plant is a new item. The money is needed for the purchase of steam and electric equipment. The estimates set forth that the present power and electric service plant at the experiment station is on the eve of breakdown.

The item of $30,000 for inquiries and investigations of petroleum and natural gas is for the first time placed separately in the estimates and represents an increase. It calls for inquiries and investigations concerning the mining, preparation, treatment and utilization of petroleum and natural gas, with a view to economic development, and conserving resources through the prevention of waste. On this subject, the estimate contains the following statement:

In 1911 the total value of the petroleum produced in this country was $134,044,752; that of the natural gas usefully produced was $74,127,534. The magnitude of the petroleum industry, the increasing value of petroleum and natural gas

as fuel, and the rapid decline of the yield from many fields emphasize the need of conducting inquiries concerning the mining, treatment and utilization of petroleum and natural gas, with a view to economical and efficient development of these resources, as well as inquiries into the economic conditions that have developed in the oil and gas industries, with a view to the determination of the factors governing production and the means whereby supplies of oil and gas, especially those on public lands or on lands controlled by the Government, can be utilized to best advantage in promoting the public welfare.

As illustrating the need for inquiries and investigations concerning petroleum and natural gas, with a view to economic development, it is pertinent to note the following extract from a recent report received by the Bureau of Mines regarding the Cushing field of Oklahoma: "The maximum yield of oil from the Cushing field has never reached 30,000 bbl. per day. For a long period it has been considerably less than 20,000 bbl. per day. The average value of oil at the highest market quotation probably lies below $20,000 per day. During this time there has been wasting from drilling wells not less than 100,000,000 cu.ft. of gas, while the waste from flowing wells is perhaps in excess of 200,000,000 cu.ft., making a total daily waste of 300,000,000 cu.ft., which, at the domestic rate of 25c. per 1000 cu.ft., would be $75,000 per day in fuel, or a matter of perhaps $20,000 a day to the oil producer. It is not only possible to conserve this gas, but it also is possible in many cases to so manage the wells that they can furnish oil without allowing the gas to escape. The main purpose of the oil producer is to get the oil and let the gas escape." There are other fields in the United States where enormous daily waste of gas occurs.

Practically all the oil purchased by the different branches of the service of the United States has been tested by the Bureau of Mines. This is particularly true of tests for the Navy Department, these purchases amounting during the past year to about 21,000,000 gal. of oil.

Germany Will Exhibit at the Fair

A Berlin dispatch says that, "Despite the aloofness of official Germany regarding the Panama-Pacific Exposition in San Francisco in 1915, there is ground for the belief that Germany will send the biggest exhibit in her history to the exposition. Arrangements have already been made by 1400 large firms to show their wares which the great shipping lines will convey to the Pacific free of cost. A petition is about to be presented to the Reichstag by the Independent San Francisco committee asking for an appropriation of $500,000 for a German building at the exposition, saying that an adequate display is of vital necessity to German industry. Otherwise, the petitioners say, Great Britain will be allowed to crowd Germany out in the markets of North and South America, especially in regard to textiles and machinery.

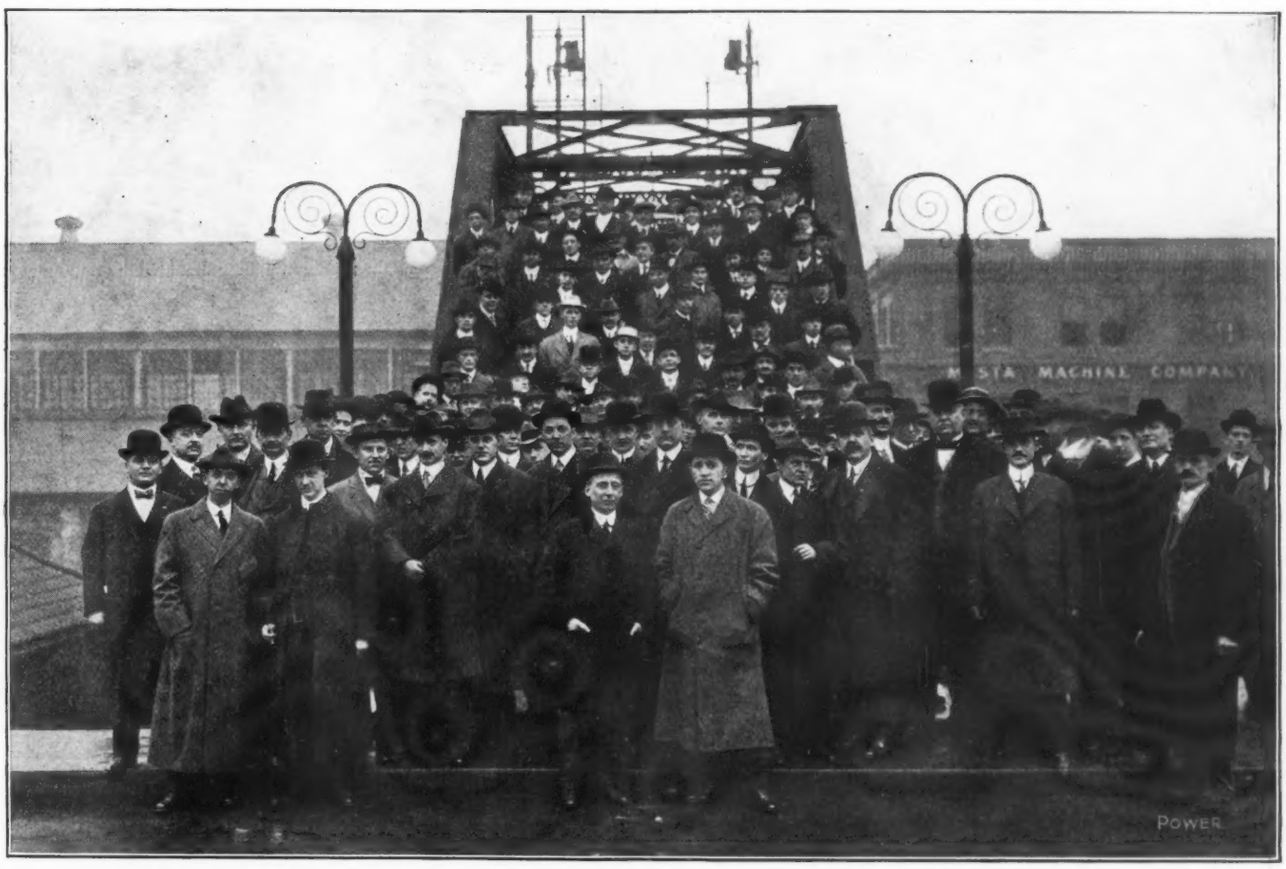
The petition says Germany has no right to boycott the exposition in consequence of an agreement with Great Britain.

It is believed the object of the petitioners is supported by a sufficiently strong body in the Reichstag to insure the voting of the appropriation.

Manufacturers and Engineers Visit Mesta Works

The Engineers Society of Western Pennsylvania and other prominent engineers and iron and steel manufacturers visited the works of the Mesta Machine Co., West Homestead, Penn., Saturday afternoon, Nov. 29, by special train, there being about 250 in the party.

The principal object of the visit was to inspect the 46-in. slabbing mill, the 44 and 76 by 60-in. twin-tandem-compound geared reversing engine and the 44x60-in. three-

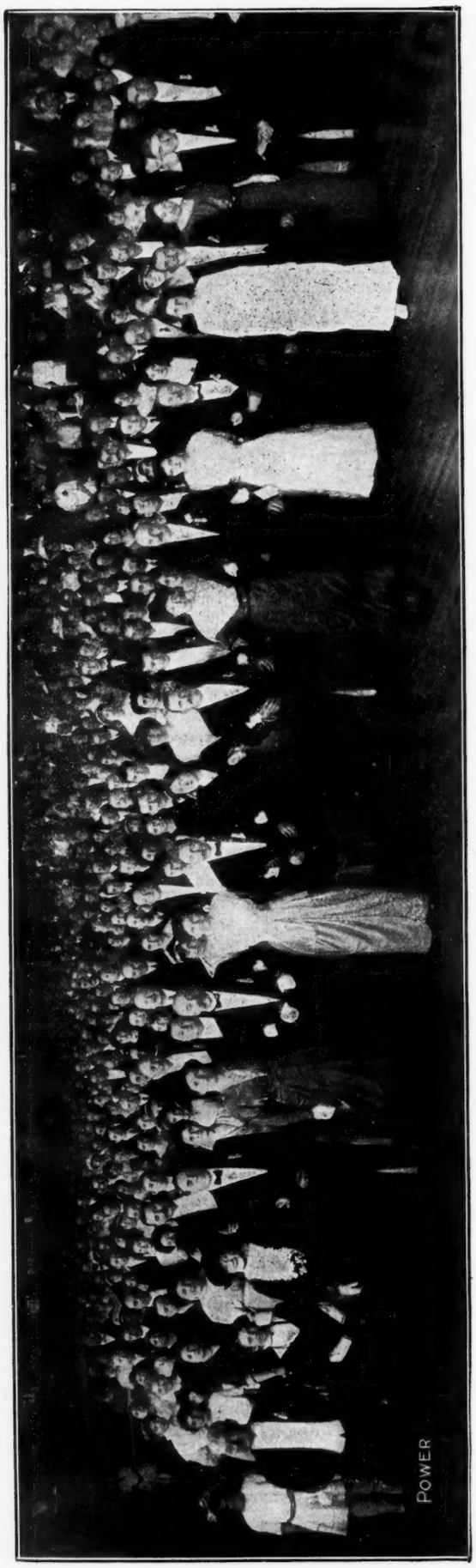


ENGINEERS SOCIETY OF WESTERN PENNSYLVANIA AND OTHER PROMINENT VISITORS AT THE WORKS OF THE MESTA MACHINE CO.

cylinder reversing engine which the Mesta Machine Co. has designed and built for the Gary Works of the United States Steel Corporation. The large engine is capable of developing 25,000 hp. and weighs about 1000 tons. The total weight of the mill and engines is about 4250 tons.

The mill will be used at the Gary Works for rolling large steel ingots up to 50 tons in weight, into slabs for the other finishing mills. The rolling mill is said to be the largest of its kind in the world. Some of the castings in this equipment weigh about 90 tons, and it will require 85 cars to transport it to the Gary Works at Gary, Ind.

The Mesta Machine Co. is running to full capacity and at present has enough orders on its books to keep it busy at full capacity for some time to come. Several of the principal orders on hand are for a large twin-tandem compound reversing engine for Corrigan, McKinney & Co., Cleveland, Ohio, and two large cross-compound blast furnace blowing engines for the Woodward Iron Co., Woodward, Ala., and some rolling mills for the Bethlehem Steel Co. The company also has orders for some rolling-mill equipment for the Canadian Car & Foundry Co., Fort William, Ont., and the Imperial Steel Works of Japan.



RECEPTION OF THE COMBINED ASSOCIATIONS OF ENGINEERS OF BROOKLYN

New York "Museums of the Peaceful Arts"

Steps have been taken to found a group of museums in New York City, to be known as "The Museums of the Peaceful Arts." The group is to consist of 20 buildings, and when completed will constitute the greatest institution of its kind in the world.

A site is to be procured sufficient to meet the needs of the entire project, but in the beginning only one or two buildings will be erected. The entire cost of the group is estimated at about $30,000,000, and the annual maintenance charges at between $2,000,000 and $3,000,000.

It is proposed that the museums shall be divided into the following branches: Electricity, steam, astronomy and navigation, safety appliances, aviation, mechanical arts, agriculture, mining, labor, efficiency, historic records, health and hygiene, textiles, ceramics and clays, architecture, scenic embellishment, gardening, roads and road-building materials, commerce and trade, printing and books. In addition there will be a central library containing books and periodicals relating to the subjects of the museum.

This is the first project looking toward the establishment of a museum of science and industry to take definite form in the United States. The outline is splendid in its breadth and scope; if carried through to completion, this museum will be a worthy companion of the two other great museums in New York City.

SOCIETY NOTES

The American Association for the Advancement of Science will hold its sixty-fifth meeting at Atlanta, Ga., on Dec. 29 to Jan. 3.

The Marine Engineers' Beneficial Association will hold its 39th annual convention in Washington, D. C., beginning Dec. 19 and concluding on Dec. 24. The Raleigh will be the headquarters. A large attendance of delegates and guests has been promised.

About the middle of January the Chicago Section of the American Society of Mechanical Engineers will hold a meeting having for its subject "Steam Power Plants." The speakers will be men in charge of some of the largest power plants in the country. At the section's dinner meeting, Nov. 19, there was an attendance of 162 members and guests.

The annual masque and civic ball of Local No. 56, International Union of Steam and Operating Engineers, was held on Saturday evening, Dec. 6, at Brooklyn Labor Lyceum. The attendance was large and the costumes were attractive. The reception committee was composed of Frank H. Schmitz, chairman; Charles Freiermuth, Charles F. Liebmann, Joseph Munterfering and Conrad Ehle.

On Saturday evening, Dec. 6, the sixth annual entertainment and reception of the Combined Associations of Engineers in the Borough of Brooklyn was held in Kismet Temple, and was most successful. Delegates were present from Local Associations Nos. 8, 27, 41, 57, Melville Council No. 9 and the Modern Science Club. The reception committee included G. W. Roff, J. O. Westberg, William Smith, Charles Schabacker, W. F. Brundage, C. A. Enggren and G. O. Kaley. Frank Martin was floor manager. On the entertainment program were Nichols Brothers, Madeleine Livingston, the Schaefers, Harry Burgoyne, Allen and Dalton, the New York Quartet, Larry Sharkey and Clark and Watson.

PERSONALS

Irvin S. Chamberlain, a member of No. 2 Association, N. A. S. E., of Paterson, N. J., has been appointed chief engineer of the new United States Post Office Building at Jersey City.

John A. Drew, for over 25 years the New York sales manager for Henry R. Worthington and the International Steam Pump Co., has accepted the position of specia' sales agent with the Epping-Carpenter Pump Co.

H. M. Montgomery, for many years the Western representative of the Alberger Condenser Co., has been appointed the Western representative of the Permutite Co., which exploits a new water-softening and scale-preventing process.